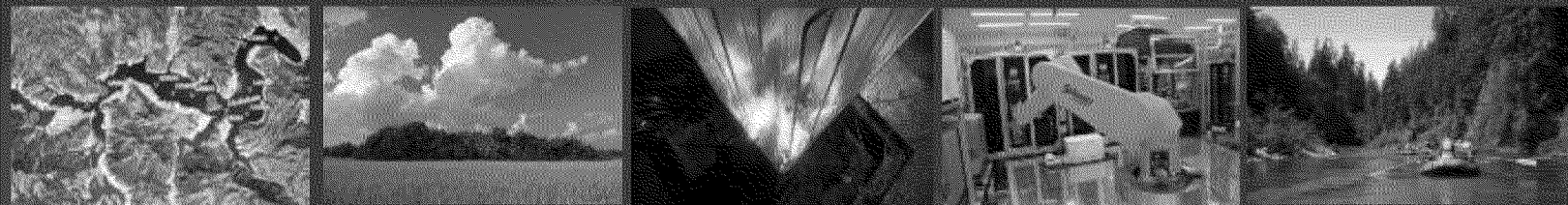




**U.S. EPA Office of Research and Development and
Environmental Council of the States**
Partners for Meeting State Research Needs

September 2017



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The success of environmental protection and public health in the United States begins on the front lines at the state and local levels. EPA's Office of Research and Development (EPA ORD) is a vital scientific and technical resource to states and their communities, providing the technical support and training, science-based tools, and innovative approaches and methods they need to meet their highest priority environmental and related public health challenges, while also laying the groundwork for long-term health and prosperity.

Collaboration and teamwork with state environmental agencies make that all possible. EPA ORD has developed critical partnerships to ensure our work is relevant to real-world environmental challenges and that scientific findings and tools are delivered to decision makers in ways that make them immediately accessible and useful. EPA ORD has partnered with the Environmental Council of the States (ECOS, the national association of state environmental agency leaders) and its research arm, the Environmental Research Institute of the States (ERIS), to ensure that our research is useful and practical for states to help address their on-the-ground problems.

Our state partners provide significant insights into the environmental problems they face and how EPA can best translate ORD science into well-informed decision tools for states and communities. Over the past six years, ERIS and EPA ORD have strengthened the alignment of EPA's scientific and technical capabilities with state research priorities and needs through a series of meetings and state surveys. As a result of this effort, EPA ORD better understands the science needs of state environmental agencies, and states better understand EPA ORD's research, tools and role within EPA. As recently as 2016, states identified their needs and grouped them into broad topics, such as water, emerging contaminants/toxics, waste/remediation and air/ozone. EPA ORD values the information the ERIS survey provides, as it will help us to continue to align our research program with state science needs.

This document compiles summaries of how EPA ORD's work during the past five years, in partnership with state agencies, counties, communities and universities, has supported states in their efforts to protect human health and the environment. These stories highlight a wide range of research, development, decision support tools and technical assistance efforts focusing on air and water pollution, chemicals, Superfund and other contaminated site remediation, infrastructure and homeland security – all of which are vitally important to helping states address the highest priority, on the ground problems.

We look forward to continuing to build our partnership with ERIS to develop the science that meets states' immediate and long-term needs.

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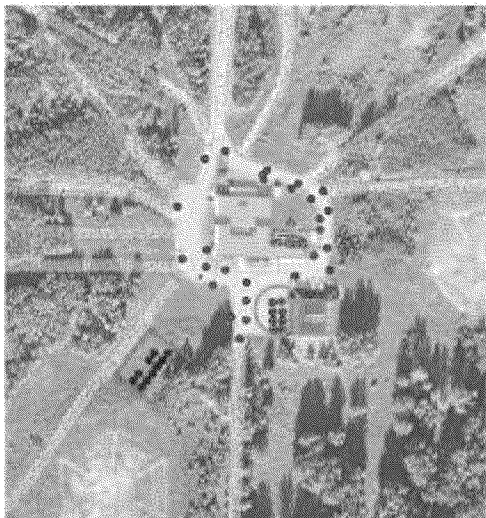
ALASKA

Partner: Alaska Department of Environmental Conservation (ADEC)

Challenge: Contaminated site due to PFAS issues at Joint Base Elmendorf-Richardson (ongoing)

Resource: Technical support for site contamination in collaboration with the U.S. Air Force

“EPA’s collaboration with the ADEC and the Air Force on PFAS sampling and analytical methods is key to ensuring valid, defensible data are collected on these emerging contaminants that are being found in soil, groundwater and drinking water in Alaska and elsewhere across the country. Extremely low concentrations, in the parts per trillion levels, in drinking water may pose unacceptable health risks, thus, rigorous sampling and analytical methods are critical in ensuring people have clean drinking water.” – ADEC Commissioner Larry Hartig



With increased concern about the risk of per- and poly-fluorinated alkyl substances (PFAS) in drinking water, it is important to identify the source(s) of the contamination and manage/remediate the risk. To date, PFAS contamination has been observed at landfills, primary and secondary PFAS-related manufacturing sites, wastewater treatment plants, and emergency response and training sites where aqueous film forming foams (AFFF) were used for firefighting. The Department of Defense has identified hundreds of sites with potential AFFF contamination.

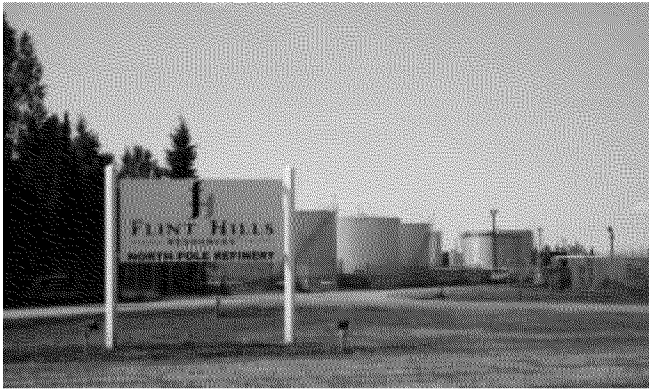
EPA ORD, in coordination with Region 10 (Pacific Northwest), is providing technical support for PFAS site characterization at Joint Base Elmendorf Richardson (JBER) in Anchorage. ORD previously provided a review of an Air Force work plan to collect groundwater and soil samples at JBER for PFAS analysis. ORD scientists will observe

the collection of groundwater samples by an Air Force contractor, visit locations where samples have been collected, and collect wastewater and creek samples. ORD scientists will analyze splits of some samples to evaluate the American Society for Testing and Materials (ASTM) analytical PFAS methods (ASTM 7968-14 and ASTM 7979-15). This will provide an opportunity to apply the ASTM methods to additional environmental matrices analyzed to date, as well as analyze samples for PFAS precursors. The resulting data from the Air Force and ORD can be used to decide further site characterization priorities.

Partner: Alaska Department of Environmental Conservation (ADEC)

Challenge: Toxicity information for sulfolane to inform cleanup levels (completed)

Resource: Peer review of the available reference doses (RfDs) and technical support



"EPA's technical experts played a vital part in assisting the state of Alaska in understanding the risks of sulfolane in groundwater and the potential impacts to public health. EPA provided critical information on sulfolane mobility, toxicity and human health exposures that greatly assisted ADEC in making decisions on protecting residents. ADEC appreciates EPA for all their timely support and help by providing information on the best available science which was significant in Alaska's response actions for sulfolane." — ADEC Division of Spill Prevention and Response Director Kristin Ryan

Sulfolane is an industrial solvent used in gasoline production and petroleum refining. The discovery in late 2009 of sulfolane in drinking water wells near the Flint Hills North Pole Refinery (about 15 miles east of Fairbanks, AK), led to an extensive investigation of contaminated groundwater. The groundwater plume is approximately 2 miles wide, 3.5 miles long and over 300 feet deep, rendering it one of the largest in the state, with many private properties impacted. The National Toxicology Program (NTP) began new animal studies on sulfolane in 2014.

EPA's Region 10 (Pacific Northwest) requested that ORD conduct a Provisional Peer-Reviewed Toxicity Value (PPRTV) assessment for sulfolane. The information in PPRTV assessments can be used in combination with exposure information to characterize the public health risks of a given substance at a particular hazardous waste site. Importantly, these risk characterizations can form the basis for risk-based decision making, regulatory activities, and other risk management decisions designed to characterize and protect public health. EPA ORD finalized the PPRTV assessment in 2012.

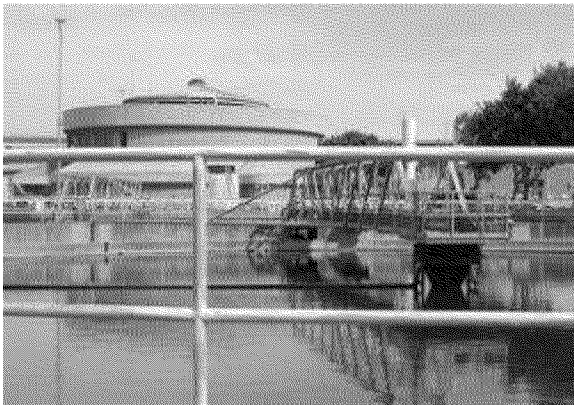
At ADEC's request in 2014, EPA ORD scientists participated in an independent, expert peer review workshop to discuss the available oral toxicity values/reference doses for sulfolane (including the PPRTV) and reach conclusions based on the available science. EPA ORD scientists provided essential technical support in the peer review workshop with respect to the scientific development process of the Sulfolane PPRTV assessment. This technical support assisted ADEC in their consideration of cleanup levels for contaminated groundwater. Ultimately, ADEC decided to wait to set a cleanup level for sulfolane until more data become available from the new NTP studies (target 2019), in order to best protect people from exposure. EPA ORD's input provided ADEC with important information that will be needed for making a final determination.

CALIFORNIA

Partners: State of California and San Francisco Public Utilities Commission (SFPUC)

Challenge: Providing sufficient, quality water to meet increasing demands (ongoing)

Resource: Assessment model for introduction of novel water technologies



“SFPUC values the research being done by EPA ORD in the field of decentralized non-potable water systems. ORD is building upon completed research to provide much needed, additional support—in terms of characterizing pathogen concentrations and identifying potential surrogates that can be used to monitor treatment process performance—towards the goal of reducing exposure to pathogens.” – SFPUC Director of Water Resources Paula Kehoe

Through our collaborations with the state of California and the SFPUC, EPA ORD is developing and testing assessment methods to identify optimum technologies for using

alternative waters (sources) for non-potable and potable purposes. Changes in drinking water and wastewater management strategies to meet state and local demands has led to new approaches (e.g. membrane bio-reactors) for developing and implementing additions and improvement to current water treatment and delivery schemes. In addition to these approaches, there is also interest in utilizing alternative waters (sources) in community water systems. To utilize these alternative waters, communities are now faced with additional challenges to ensure the same water quality is delivered, as well as optimizing resource recovery and system efficiency when using alternative waters for non-potable and potable purposes.

SFPUC leads an effort to implement decentralized non-potable water systems that involves a group of stakeholders from across the country, including a range of water utilities (Austin, Denver, Los Angeles, Portland, Seattle and Washington, DC) and public health departments (California, Colorado, Hawaii, Minnesota, Washington and New York City). EPA ORD is assisting by developing and assessing the risk-based log reduction targets related to fit-for-purpose water use. This integrated assessment also includes life cycle costs, and potential environmental (particularly energy) and human health impacts. EPA ORD’s work will provide the state and various utilities and public health departments with a system-level approach and framework that will quantitatively evaluate the tradeoffs that exist among alternative processes and identify which configuration delivers a robust and sustainable water system design.

Partner: City of San Francisco

Challenge: Testing the decontamination of a Bay Area Rapid Transit railcar contaminated with a non-pathogenic anthrax surrogate (completed)

Resources: Technical assistance and field support in collaboration with the U.S Department of Homeland Security and U.S. Department of Energy labs



"The Underground Restoration Project has been instrumental in assisting the San Francisco Bay Area Rapid Transit (BART) District prepare for a biological incident. BART does not have subject matter experts on staff, who can plan, prepare, develop and/or respond to a bio incident. Underground Transport Restoration Guidance prepares the agency for an unthinkable incident to a 'do-able' response. The tabletop exercise and guidance documents help us support and coordinate the regional management and

response to an incident, allowing our service to be restored in a safe and timely manner. Without having the opportunity to participate in the project, if there was an actual event, the San Francisco region would be responding blindly, without plans in place, which would negatively impact lives, property and the environment."
 —BART Police Department Security Programs Manager Lt. Kevin Franklin

Release of biothreat agents, such as *Bacillus anthracis* (*Ba*) spores, by terrorists into an underground subway system could have devastating impacts on human health and the functioning of cities such as New York, Chicago, Washington, DC, and San Francisco. This critical transportation infrastructure could be down for weeks or months during the cleanup; in addition, the spores are likely to travel to street level, further affecting people's lives and the economy.

As part of the Department of Homeland Security's (DHS) Underground Transport Restoration (UTR) project, EPA ORD, Sandia National Laboratories (Sandia) and Lawrence Livermore National Laboratory (LLNL), in conjunction with DHS, conducted a scientific study in July 2015 to evaluate methyl bromide as a fumigant for decontaminating subway railcars contaminated with *Ba* using non-pathogenic *Ba* Sterne strain spores. The study was conducted to gain large-scale information on the use of methyl bromide for the decontamination of *Ba* spores, and to develop site-specific plans and guidance that could be modified and used during a real-world incident. The fumigant, methyl bromide, was selected because it has shown to be effective in the inactivation of *Ba* spores during laboratory testing, is less corrosive than most other fumigants, and can be captured on activated carbon.

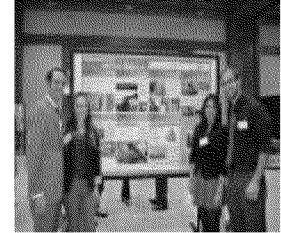
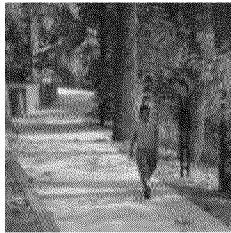
At the conclusion of the 36-hour fumigation period, the railcar was aerated and samples were collected and sent for analysis. Results showed that none of the 40 fiberglass or 40 aluminum test samples contained viable spores after fumigation while a few samples of the nylon carpet, rubber flooring sample, Mylar® and vinyl seating showed low but positive residual spore levels. As a result of these findings, EPA recommends fumigating railcars with methyl bromide for a 48-hour period to achieve complete decontamination.

Partners: California State University System

Challenge: Framework and decision support tools to advance priority projects in local government work plans (ongoing)

Resource: Supporting campus-community partnerships through the EPIC Framework and EPA tools

"This model shows us how to work together with the university to create a meaningful partnership to take on projects the city needs done. EPA has



been an integral part of making this happen. It gave credibility to the project, to our city manager.... we're very thankful for their participation in bringing this together."— City of Chico Council Member and former Mayor Ann Schwab

Environmental and public health impacts affect people most significantly at the community level. Local governments and communities often lack capacity and need assistance managing pollution, natural resources, energy, water and waste. Creative approaches are needed to supply expertise and assistance to communities. An Educational Partnership for Innovation in Communities (EPIC) program is a partnership framework where a university (campus) provides direct support to a city, tribe or other local government entity to implement priorities and projects that align with local goals for protecting the environment while advancing public health, environmental and economic outcomes. The EPIC framework systematically matches real-world interests and needs with university capacity at a scale that can have lasting and sustainable impacts for all involved. EPA ORD and Region 9 (Pacific Southwest) staff have been working together to convene and educate potential campus-city partners about the framework; and leverage the EPIC network to more effectively share EPA resources and science-based decision tools and strategies that can be used to advance local projects.

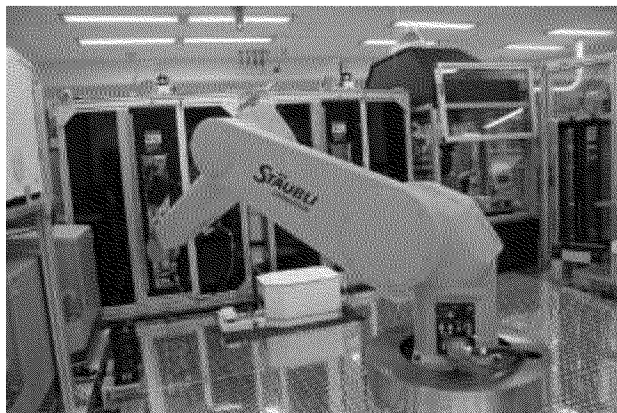
In July 2015, EPA sponsored a workshop in California that convened 76 participants including federal and local government, university and industry representatives to educate them on the EPIC Framework and EPA tools for protecting the environment while promoting local health and economic goals. This event included a panel with San Diego State University's EPIC Program, The Sage Project, and National City – their first local partner.

From this workshop, six new California EPIC programs formed between California State Universities and local governments. These include Fresno, Chico and Sonoma State, and Cal State's Monterey Bay, San Marcos, East Bay and Fullerton. The partnerships have allowed students and faculty to work on dozens of city priority projects, gaining real-world learning experiences and applying tens of thousands of student hours to local challenges. Some projects involving students will tap into their role as citizen scientist. Several partnerships are also using EPA mapping tools, such as EnviroAtlas and the Community-Focused Exposure and Risk Screening Tool (C-FERST), to help inform better decision making to enhance the well-being of local residents.

Partners: California Environmental Protection Agency's (CalEPA) Department of Toxic Substances Control (DTSC) and Office of Environmental Health Hazard Assessment (OEHHA)

Challenge: Evaluating chemicals for health effects (ongoing)

Resource: New technologies, models, tools, data and other chemical information



"California benefits significantly from our partnership with EPA ORD. We use ToxCast data to provide valuable insight into how chemicals may cause toxicity, and we use their lifecycle analytic and exposure modeling and monitoring for various state efforts including our work on safer consumer products. EPA ORD resources are helping us to make more informed decisions about the potential health effects of chemicals." – CalEPA Secretary Matthew Rodriquez

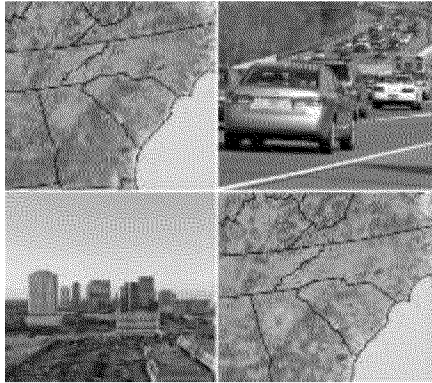
CalEPA's DTSC and OEHHA are collaborating with EPA ORD on the following projects: 1) using ORD's new technologies and computational modeling approaches to evaluate the potential health effects of chemicals; 2) improving and using ORD science for evaluating the risk of chemical exposure to threatened and endangered species; and 3) a collaboration which includes EPA's Region 9 (Pacific Southwest) and Office of Chemical Safety and Pollution Prevention to advance sustainable chemistry practices and activities.

ORD researchers have provided CalEPA staff training on the use and interpretation of the high-throughput chemical testing data contained in the ToxCast Dashboard (<http://actor.epa.gov/dashboard/>); planned and participated in a workshop to discuss an endangered species case study in the Sacramento River Basin; and shared database architecture to help the state develop chemical information databases. This collaboration is helping California use scientific advances to make more informed decisions about the potential health effects of chemicals, as well as determine safer and more sustainable uses of chemicals found in products that consumers buy and use.

Partners: California Energy Commission

Challenge: Population and land use projections to the year 2100 consistent with emissions storylines (completed)

Resource: Integrated Climate and Land Use Scenarios (ICLUS) version 2



"It is extraordinarily beneficial to climate planning in California to be able to rely on tools like ICLUS v2 to provide a federally-vetted baseline for coordinated climate assessment research." – California Natural Resources Agency, Special Assistant for Climate Change JR De la Rosa

EPA ORD researchers developed national population, land use and impervious surface projections that the state of California used in its Third Climate Change Assessment. For the upcoming fourth assessment, the state will use EPA's updated climate model, the Integrated Climate and Land Use Scenarios version 2 (ICLUS v2), as a basis for land use scenarios in California, with minor modifications as necessary. These scenarios will

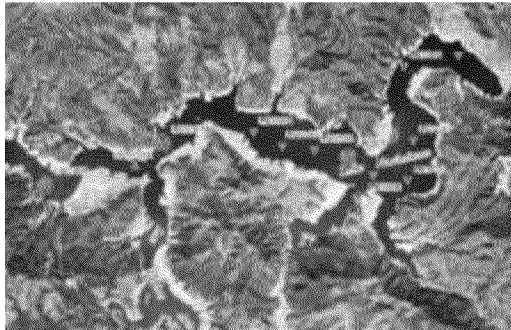
be used across multi-disciplinary and multi-sectoral research that informs the Fourth Assessment.

ICLUS v2 uses the latest census, land use and land cover datasets to model population growth, residential housing changes, and commercial and industrial development nationally to the year 2100. Projections use information on fertility, mortality and international immigration rates that are consistent with global storylines (e.g., Shared Socioeconomic Pathways) used in climate change impacts, vulnerability and adaptation assessments. In addition, ICLUS v2 projections use information on domestic migration, including how future climate may make certain places more desirable. Combined with the addition of commercial and industrial land uses, the updated projections from ICLUS v2 will help the state of California better assess potential future impacts from climate change and prepare adaptation and mitigation responses.

Partners: California Regional Water Control Board

Challenge: Reducing mercury methylation in the Nacimientio Reservoir (ongoing)

Resource: Technical investigation



“Understanding mercury methylation and cycling of mercury in the aquatic environment is particularly important to states and communities that oversee health advisories for fish consumption. The Lake Nacimientio study could help to enhance our understanding of mercury methylation and controls in reservoirs.”—California EPA Environmental Engineer Carrie Austin

Although operations ended in 1970, the legacy of previous mercury mining and processing activities at the Buena Vista, California mining district still pose environmental and related public health concerns. Mercury from the Buena Vista Superfund Site that enters the local watershed drains into the Nacimientio Reservoir. Researchers have identified active zones of methylation—when mercury is converted into a form that easily enters the food chain—in the reservoir’s water columns and sediments.

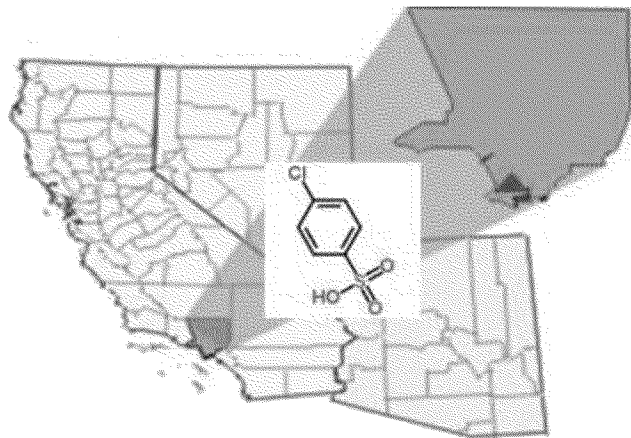
Several remediation options are currently under consideration to protect the public from mercury exposure and its detrimental impact on the nervous system. Researchers from EPA ORD are working closely with their colleagues in Region 9 (Pacific Southwest) to identify the best ones. Together, they worked to determine how much methyl mercury in the water column comes from methylation taking place in reservoir sediment, and to identify the effect that higher dissolved oxygen levels in the water column can have on the methylation process. Results showed that methylmercury production was primarily taking place within the water column, and that reservoir sediment was not a significant contributor due to much lower methylation rates; additionally, increased levels of dissolved oxygen would reduce overall water column methylation.

The information will help site managers focus on remediation activities that alter water column chemistry, increase levels of dissolved oxygen, and utilize reservoir management strategies, thereby reducing seasonal fluctuations of methyl mercury production.

Partner: California Environmental Protection Agency (CalEPA)

Challenge: Set a risk-based cleanup level for para-Chlorobenzene Sulfonic Acid (p-CBSA) (completed)

Resource: Provisional Peer-Reviewed Toxicity Value (PPRTV) for p-CBSA



"When a chemical that had not been well-studied threatened an important drinking water aquifer in the L.A. Basin, scientists from ORD were important partners. They worked collaboratively with our state scientists to develop a risk assessment using the best available science." – CalEPA Secretary Matthew Rodriquez

The potential toxic effects of para-Chlorobenzene Sulfonic Acid (p-CBSA), a by-product of the production of the "probable human carcinogen" DDT, present health concerns, particularly for drinking water contamination because the chemical is highly water soluble and mobile in aqueous environments. It has been identified in

potential drinking water sources beneath and near sites in California, such as the former Montrose Chemical Corporation where DDT was manufactured from the 1950s to the early 1980s.

Because of high interest in evaluating the potential human health effects of p-CBSA, CalEPA and EPA ORD, in collaboration with Region 9 (Pacific Southwest), worked together in assembling existing study data leading to the development of a Provisional Peer-Reviewed Toxicity Value (PPRTV). Importantly, the information in PPRTV assessments can be used in combination with exposure metrics to characterize the public health risks of a given substance at a particular Superfund site. These risk characterizations can form the basis for risk-based decision making, regulatory activities and other risk management decisions designed to characterize and protect human health.

EPA ORD's PPRTV assessment identified information sufficient for derivation of a provisional reference value that informs risk associated with oral p-CBSA exposures. The impact of this work will be realized in the facilitation of risk-based decision making and activities on sites contaminated with p-CBSA.

Partners: San Francisco Estuary Institute (SFEI)

Challenge: Reduced ecosystem resilience and stability of San Francisco Bay from nutrient pollution (ongoing)

Resource: Statistical evaluation of 40 years of monitoring data in the San Francisco Delta region



"EPA ORD provided critical expertise in developing a scientifically-defensible approach to estimating chlorophyll-a concentrations in San Francisco Bay that would be protective of designated uses. This work is forming a foundation of science that will be ultimately used to develop nutrient management strategies for San Francisco Bay, which is one of the most nutrient-enriched estuaries in the United States." – Southern California Coastal Water Research Project Authority, Biogeochemistry Department Head Martha Sutula, PhD

San Francisco Estuary on the Pacific Coast of the U.S. is one of the most prominent—and closely monitored—estuaries in the western hemisphere. A robust database compiled over the past four decades has revealed that the Bay has consistently high nutrient concentrations, yet has rarely experienced eutrophication. Recent changes in land use and weather, however, could lead to changes from the historic norm.

Local management agencies have prioritized the analysis of the monitoring data collected over the years from the Delta region surrounding San Francisco Bay, a complex mosaic of inflows that receive, process and export nutrients from the watershed to the lower Bay, as a preliminary approach to understanding large-scale properties of the Bay.

EPA researchers are helping to conduct the first comprehensive evaluation of the long-term monitoring dataset in the Delta. In collaboration with SFEI researchers, they have applied statistical models for trend analysis to better understand regional water quality dynamics. The Weighted Regressions on Time, Discharge and Season (WRTDS) model was used to provide the descriptive potential of long-term data by describing variation in flow-normalized concentrations, frequency of occurrence of extreme events, and nutrient response to historical changes. Results will provide scientific support for nutrient criteria development, Total Maximum Daily Load implementations, and routine condition assessments. Information provided by these models can also be used to generate and test hypotheses of how responses to anthropogenic nutrient interacts with other environmental changes to cause eutrophication.

Partners: California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA)

Challenge: Addressing safety concerns of recycled tire crumbs used in synthetic turf fields and playgrounds (ongoing)

Resource: Research for improved exposure assessment in collaboration with the Centers for Disease Control and Prevention and the U.S. Consumer Products Safety Commission

"Scientists at both U.S. EPA and our office are conducting comprehensive studies on crumb rubber and synthetic turf to answer a very important public health question: 'Is it safe for our children to play on synthetic turf?' The U.S. EPA study complements and strengthens what we are doing in California. Consultations with the U.S. EPA scientists benefit our project team and help to improve the quality of the California synthetic turf study."

– CalEPA OEHHA Senior Toxicologist Dr. Patty Wong

EPA ORD is collaborating with the Centers for Disease Control and Prevention (National Center for Environmental Health and Agency for Toxic Substances and Disease Registry) and the U.S. Consumer Product Safety Commission to study key environmental and human health questions. To address the concerns that have been raised about the safety of recycled rubber tire crumbs, a Federal Research Action Plan was developed to investigate key factors that could have environmental and human health implications. EPA ORD was involved with four elements described in the Federal Research Action Plan: conduct a literature review and data gaps analysis, conduct outreach with key stakeholders, perform tire crumb rubber characterization research, and perform human exposure characterization research.

The research supported by EPA ORD is intended to characterize a wide range of chemical, physical and microbiological constituents and properties for tire crumb rubber infill material collected from tire recycling plants and synthetic turf fields around the U.S., and to assess factors that may affect exposures to these constituents by field users. Data collected will provide important information about the types and amounts of chemical constituents in the tire crumb rubber material to which humans might be exposed through skin absorption, ingestion or breathing. Researchers will also be looking at human activity parameters on synthetic turf fields that may affect how they might be exposed to tire crumb rubber constituents.



Researchers at CalEPA OEHHA are also conducting research aimed at reducing data gaps for tire crumb rubber constituents and human exposures. The federal research team regularly consults with OEHHA scientists to discuss how the two studies can be mutually informative. The federal and state researchers will identify and implement methods and approaches that will, where feasible, produce comparable data. This could effectively expand the overall U.S. research sample size and will provide additional insight into potential exposure variability. There are also important differences between the federal and OEHHA studies that will provide complementary data for improved exposure assessment.

FLORIDA

Partners: Florida Department of Environmental Protection (DEP), South Florida Water Management District (SFWMD)

Challenge: Saltwater encroachment damaging freshwater vegetation communities in the floodplain (ongoing)

Resource: Time series salinity model as a tool for development and evaluation of restoration alternatives



“The salinity tool will allow the ecological sub-team of the Loxahatchee River Watershed Restoration Project to evaluate the various potential project features in order to determine what grouping of features such as storage reservoirs, storm water treatment facilities, and restored wetlands performs the best for the restoration of flows to the federally designated Northwest Fork of the Loxahatchee River. The tool allows us to take the differing flow scenarios from the watershed and predict how those flows will change the salinity regimes in the river and therefore affect the location, health and survival of key

indicator species such as juvenile fish, submerged aquatic vegetation and oysters.” – SFWMD Applied Science Bureau, Coastal Ecosystems Section Science Supervisor Patti Gorman

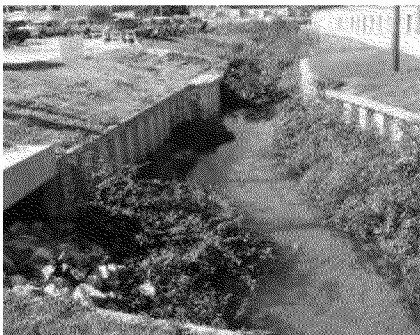
Loxahatchee River contains a diverse array of aquatic and riparian ecosystems, with the upper reach being home to one of the last remnants of bald cypress (*Taxodium distichum*) floodplain swamp in southeast Florida. In 1985, a 16.6-km stretch of the river became Florida’s first federally-designated National Wild and Scenic River. The unique ecosystem of the Loxahatchee River, with its quiet beauty, has captured the attention and imagination of residents and visitors, as well as agency and community leaders for many years. However, anthropogenic alterations of the Loxahatchee River watershed, particularly the permanent opening of the Jupiter Inlet and construction of drainage canals, have resulted in significant encroachment of a saltwater-tolerant, mangrove-dominated community into the freshwater floodplain currently dominated by bald cypress. Restoration of the ecosystem has become a priority for federal, state and local agencies and the general public.

Essential to the restoration of the Loxahatchee River ecosystem are technically sound modeling tools for the development and screening of restoration alternatives. EPA ORD scientists developed a salinity modeling tool implemented in a user-friendly Excel® platform. Salinity can be simulated with a given time series of freshwater inflow associated with varying restoration alternatives developed during the planning process. Spatial features of the tool also allow for estimation of salinities at any designated locations along the entire reach of the river. The simulated salinity data are further used to quantify the ecological benefits with respect to habitat lifts of freshwater floodplain vegetation, fish larvae, oysters and seagrasses in response to these varying restoration alternatives. Stakeholders from the SFWMD and Florida DEP are using this tool in the development of restoration alternatives, while EPA ORD scientists continue to provide technical support for model development and application.

Partners: Florida Department of Environmental Protection (DEP), Escambia County

Challenge: Nitrogen pollution in urban environments (ongoing)

Resource: Isotopes as tracers to identify sources of nitrogen pollution



“Our partnership with EPA ORD offers us a wonderful opportunity to gain a better understanding of nutrient loads and likely sources within the Bayou Chico and Pensacola Bay watersheds. Funding for environmental restoration is always limited. Having this understanding allows Escambia County and our partners to prioritize projects that have the greatest potential to

have a positive impact on our ability to attain our surface water quality goals. We hope to use this research in the future as the basis for better resource management decisions.” – Escambia County, Water Quality and Land Management Division Manager Brent Wipf

Bayou Chico is part of the Pensacola Bay System in northwest Florida and the subject of a basin management action plan by the Florida DEP to improve water quality through reductions in nitrogen loadings. Moreover, local governments are investing heavily to restore Bayou Chico and spur economic development in the surrounding area. Two creeks in the watershed provide an ideal urban setting to compare nitrogen loadings between contrasting land use and land coverages. Jackson Creek traverses residential and business developments and is listed as impaired for elevated fecal coliforms and nitrogen levels. Jones Creek originates in a reclaimed nature preserve/greenway and rarely exceeds water quality standards for fecal coliforms and nitrogen.

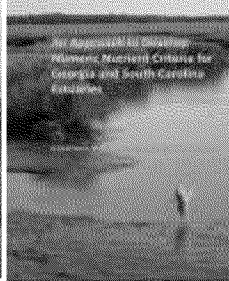
EPA ORD scientists in collaboration with Region 4 (Southeast) and partners are collecting water and sediment samples in the creeks and watershed to compare and contrast potential sources, fate and transport of nitrogen in the two creeks. Sampling locations are located along the creeks, the bayou, adjoining lakes and wells for groundwater sampling. Samples are collected on a quarterly basis for base flow measurements and more frequently around rainfall events. Samples are analyzed for a suite of water quality chemical parameters including nitrite, nitrate and chemical tracers of wastewater discharge. Elemental isotope ($\delta^{15}\text{N}$ and $\delta^{15}\text{O}$) data will be analyzed using mixing models in conjunction with water quality data to provide estimates of N loading and turnover in the two creeks and their contribution to the bayou. This project is providing the technical basis for the County and Florida DEP to better understand nutrient loads and sources in the watershed and inform decision making for the basin wide management action plan.

GEORGIA

Partner: Georgia Department of Natural Resources (DNR) Environmental Protection Division (EPD)

Challenge: Establishing a scientific framework to guide the development of numeric nutrient criteria for coastal waters (completed)

Resource: Technical support in collaboration with academic experts from Southeastern U.S.



“Georgia EPD is currently working on a collaborative project with the University of Georgia and EPA to collect data necessary to develop a water quality model to aid in setting numeric nutrient criteria for estuaries. The model will examine the sensitivity of water quality to changes in land and water use. Specifically, it combines watershed and hydrodynamic models to a water quality model, and we’re applying it to estuaries in McIntosh County, GA. The coupled modeling system will allow us to model nutrient

dynamics and the biological responses of algae, including chlorophyll and dissolved oxygen estimates, and ultimately to predict changes in water quality associated with changes in land/water use and climate change. EPA has been instrumental in guiding the collection and interpretation of data for the linked models.”—Georgia DNR EPD, Watershed Planning Manager Victoria Booth

Coastal waters are an important resource driving coastal recreation, tourism, fisheries and other economic activity. A number of states have recently taken significant steps to address nutrient pollution that threatens these uses. For example, nutrient criteria and a bay-wide Total Maximum Daily Load (TMDL) has been established for the Chesapeake Bay and its watershed, and the state of Florida adopted numeric nutrient criteria for nearly all of its estuaries and coastal waters. In both instances, widely recognized water quality issues such as seagrass loss, hypoxia and harmful algal blooms were among the useful endpoints for criteria development. The unique coasts of South Carolina and Georgia present a different challenge, however, as high tides, extensive salt marshes and naturally turbid waters create a unique but valuable ecosystem.

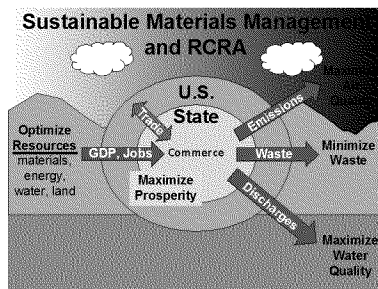
As part of EPA’s long-standing approach of supporting states to develop water quality criteria and nutrient management approaches for their waters, EPA Region 4 (Southeast) convened the Georgia-South Carolina Estuary Team (GASCET) to adapt the previously applied approaches in Florida and Chesapeake Bay to create a unique framework appropriate for the ecology of the Georgia and South Carolina coast. EPA ORD provided expertise in eutrophication and nutrient criteria development.

The team, which included local academic experts and agency representatives from both states, evaluated available scientific information and produced a report in 2015 that identified three unique classifications for coastal systems in Georgia and South Carolina. These include estuaries associated with Piedmont riverine systems, blackwater systems with coastal plain headwaters, and coastal embayments with only local freshwater inputs. The team also identified candidate criteria development approaches and evaluated their potential applicability to coastal waters in the two states. The report is being used to inform early steps in criteria development in both states, including guidance on new data to collect in support of anticipated future requirements of the process.

Partner: Georgia Department of Natural Resources (DNR) Environmental Protection Division (EPD)

Challenge: Sustainable materials management (ongoing)

Resource: Developing a model and web application to implement EPA's state-based sustainable materials management prioritization framework



"Georgia recognizes the need to adopt a life-cycle holistic perspective in managing materials. This project has given us the opportunity to input Georgia economic data to determine environmental impacts to the state for a wide number of sectors. We expect the model to allow us to consider a wide array of environmental and economic impacts when considering strategies intended to reduce waste and improve the health and environment within the state." – Georgia DNR EPD, Solid Waste Program Manager William Cook

Through the Resource Conservation and Recovery Act (RCRA), Congress gives EPA the authority and responsibility to assist states with properly managing solid and hazardous waste. The primary objectives of RCRA are to minimize the risks to human health and the environment arising from waste disposal activities and promote the conservation of valuable material and energy resources by minimizing waste.

EPA's Office of Resource Conservation and Recovery (ORCR) uses a sustainable materials management (SMM) framework to fulfill the Agency's responsibilities under RCRA. ORCR assists states in voluntarily adopting the SMM framework into their own efforts, promoting effective, efficient waste management while simultaneously promoting economic growth, resiliency and jobs. SMM engages business, all levels of government, non-profits and academia to enhance the economy and environment.

Georgia DNR/EPD expressed interest in testing EPA's SMM framework. A pilot study was initiated in 2014 involving Georgia DNR/EPD, the Georgia Department of Economic Development, the Georgia Recycling Coalition, as well as EPA's Region 4, ORCR and ORD. EPA ORD is developing an open and transparent SMM model, based on the framework, that identifies opportunities to reduce material use and potential human health and environmental burdens associated with economic activity in Georgia. The EPA ORD SMM model merges the principles of life cycle thinking with traditional economic theory and leverages data collected by EPA and other federal agencies in a way that is easily adaptable for any state. The SMM model will be the first of its kind to consider the production, use and disposal of materials within the context of human needs (e.g. food, shelter and clothing) and wants (e.g., well-being and entertainment). The SMM model is being integrated into a customizable web application using feedback from Georgia stakeholders. Once completed, Georgia DNR/EPD will be able to prioritize opportunities for SMM in Georgia and assemble appropriate stakeholders from within the state to develop potential policy alternatives that capitalize on these opportunities. The web application can then be used to evaluate these alternatives and enable state officials to determine which option best satisfies the priorities of Georgia.

IDAHO

Partners: Center for Advanced Energy Studies (CAES), a partnership between Idaho National Laboratory (INL), Boise State University, Idaho State University, University of Idaho and University of Wyoming

Challenge: Improve local management of interactions between agriculture, energy, water and air systems (ongoing)

Resource: Advanced environmental and energy modeling expertise in collaboration with the U.S. Department of Energy's Idaho National Laboratory



"The INL Energy Environment Science and Technology Directorate and CAES is proud of its collaboration with EPA ORD to develop innovative processes and strategies to improve agricultural, commercial, industrial and water security sectors. The impact of this EPA funded work will enhance energy and productivity efficiency; thus improving profitability, safety and environmental health of regional and local communities while increasing career opportunities in this exciting and important area of research." – INL Program Manager Michael Carpenter

EPA is collaborating with the Department of Energy's INL and four local universities engaged with CAES to address evolving interdependencies between energy development and the environment through an Interagency Agreement (IA) established in 2014.

Through the IA, EPA and its partners are developing modeling and simulation tools that can be used to better understand the interactions between agriculture, energy, water and air systems. This would enable local decision makers to better evaluate environmental impacts of existing and future energy development, identify potential unintended consequences of policy and management actions, and assess mitigation approaches for energy development.

The partners are also conducting research to enhance the nation's water system's resiliency; studying ways to beneficially reuse and recycle materials used in industrial production processes; and conducting a pilot project to develop advanced mapping, modeling and interpretation tools for understanding nutrient distributions in soil and water. Fertilizer use and irrigation practices can potentially increase nutrient loading in soils, which in turn, can result in decreased water quality. These new tools will be used to inform nutrient management strategies.

KANSAS

Partner: Kansas Department of Health and Environment (KDHE)

Challenge: Understanding trade-offs associated with prairie rangeland burning

Resource: Multi-model framework and decision support tool in support of Kansas Flint Hills Smoke Management



“Kansas Department of Health and Environment is excited and optimistic about the potential uses of this multi-model framework, including predicted spatial and temporal patterns of surface fuel loads, live biomass (forage), and soil moisture information that can be used to supplement our existing Flint Hills Smoke Management Plan modeling tool.” –KDHE Division of Environment Director John Mitchell

The Flint Hills ecoregion of eastern Kansas and northern Oklahoma is home to the largest (10,000 square miles) remaining contiguous natural grassland prairie in the U.S. Throughout the region, land

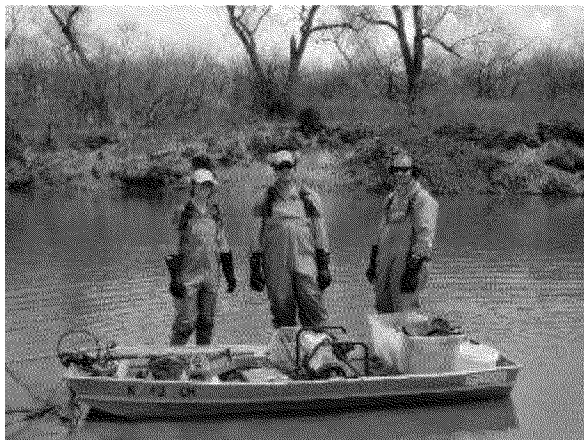
managers frequently use controlled burns to sustain the natural prairie ecosystem from the encroachment of eastern Red Cedar and other woody species, and to enhance the quantity and quality of the grasses for cattle grazing. However, smoke from widespread prescribed spring burning has exceeded air quality limits and impacted urban areas such as Kansas City, Topeka and Wichita.

To assist rangeland managers and local and state officials in better understanding the economic, ecological and human health trade-offs of rangeland burning in Flint Hills, EPA Region 7 (Midwest) and ORD are collaborating with KDHE and Kansas State University (www.ksfire.org) to establish a user-friendly, multi-model framework for visualizing historical and hypothetical burning scenarios, including changes in the location, timing and frequency of rangeland burning practices. Part of this effort involves characterizing the emissions from the Flint Hills prescribed burning in both the spring and fall seasons. ORD is conducting aerial sampling with an instrumented, tethered aerostat as well as ground sampling to derive emission factors that characterize the amount and nature of the smoke. Tangible products of the research include computer-generated spatial and temporal maps of predicted changes in rangeland productivity and air quality. Stakeholders and decision makers can use these resources to identify best case scenarios for land management that strike a balance between the environmental, economic and human health objectives of rural and urban communities.

Partners: Kansas Department of Health and Environment (KDHE)

Challenge: Efficient and defensible survey designs for stream monitoring (completed)

Resource: Probabilistic survey designs integrating national and state reporting requirements



"In my view, this collaboration with ORD is a very good example of the state-national partnership we have had with ORD. The Corvallis Lab provided the statistical expertise and analytical framework, and we provided our local knowledge and creativity and put our state level monitoring priorities on the table. The result is a survey design that is better for everyone involved." – KDHE Division of Environment Director John Mitchell

Kansas Department of Health and Environment (KDHE) is charged with reporting on the stream condition for all streams in the Kansas Surface Water Register (KSWR), which was developed in 1994.

It is a challenge for both state- and national-scale assessments to develop a survey design that ensures representativeness when only a limited number of locations are available for sampling. If the state and national monitoring efforts can be integrated, it not only supports inter-calibration but is efficient and cost-effective. EPA ORD uses a probabilistic sampling design that ensures representativeness and allows the use of statistical tools to determine condition values and the reliability of those estimates (uncertainty). This strategy has been incorporated into the NARS, which includes national-scale assessments of rivers and streams, lakes, coastal zones and wetlands. In working to refine the KSWR, KDHE was interested in whether it could be used in the National Aquatic Resource Surveys (NARS) National Rivers and Streams Assessment (NRSA).

In collaboration with EPA ORD, Kansas first conducted a study to determine if the KSWR included all the streams with flowing water required by NRSA. After determining that was the case, EPA ORD used the Kansas Register of streams as part of the NRSA 2018-19 survey design. By integrating state requirements for Kansas with NRSA requirements, Kansas reached a cost-effective solution for meeting their state assessment needs and simultaneously participating in the NRSA survey.

LOUISIANA

Partner: Louisiana Department of Environmental Quality (DEQ) and LaPlace, LA

Challenge: Potential cancer risks from emissions of chloroprene (completed)

Resource: IRIS assessment and air quality monitoring



"I want to thank EPA's Office of Research and Development for their assistance in gathering and interpreting air quality data from around the Denka Performance Elastomer facility in LaPlace, LA. The information ORD provided helped the Louisiana DEQ design and implement actions to reduce chloroprene emissions from the plant. The multi-step Denka remedy is in the first stages of its implementation and has already produced significant reductions in chloroprene emissions. When agencies work together, everyone benefits." – Louisiana DEQ Secretary Dr. Chuck Carr Brown

EPA ORD scientists assisted Region 6 (South Central U.S.) and the state of Louisiana with their evaluation of potential cancer risks from emissions of chloroprene from the Denka Performance Elastomer facility in LaPlace. Based on the risk evaluation and an engineering analyses, the company reached an agreement with Louisiana to install control equipment to significantly reduce chloroprene emissions. The facility had been identified in the EPA's National Air Toxics Assessment (December 2015) as the highest cancer risk facility in the U.S., leading to ambient air monitoring in the vicinity of the facility. The air monitoring demonstrated high levels of chloroprene in the ambient air in the surrounding neighborhood and at schools near the facility. ORD scientists and staff from the Louisiana DEQ, EPA's Region 6 and Office of Air and Radiation met with the community at a public meeting in LaPlace. EPA researchers characterized the potential health risks associated with chloroprene. The company initially questioned the science basis of EPA's Integrated Risk Information System (IRIS) assessment, but following additional communication the company has not pursued further challenges to the IRIS assessment. EPA directly supported the state of Louisiana in achieving action to reduce public health risks from the chloroprene emissions.

MAINE

Partners: Maine Department of Health and Human Services (DHHS) and Penobscot Indian Nation

Challenge: Unique contaminant exposure scenarios for tribal risk assessment (completed)

Resource: EPA report of analyses of sediment and water quality in collaboration with the Centers for Disease Control and Prevention (CDC)/Agency for Toxic Substances and Disease Registry



“The report validated our concern that Penobscot Nation tribal members may be at risk simply by carrying out cultural and traditional activities that our tribe has practiced since time immemorial.” – Penobscot Indian Nation, Director of Natural Resources John Banks

The Penobscot Indian Nation of Penobscot Island, Maine, was faced with high mercury levels in fish, triggering state fish advisories for many years. A team of EPA ORD scientists worked with the tribe to assess the environmental and human health risks in the Penobscot River watershed, which provides many of the cultural and

natural resources for the tribe. After four years of study, the team released a 125-page report that chronicles the first tribal risk assessment by EPA, as well as the first study to examine the mutagenicity of environmental samples from a tribal nation in the United States. Staff from Maine DHHS, which oversees fish consumption advisories, served as peer reviewers for the assessment.

Unique to this risk assessment was the incorporation of Penobscot culture and traditions into exposure assumptions. Hunting, fishing, trapping, gathering, basket-making, pottery and use of moccasins and birch-bark canoes were among the considerations for exposure. For example, assessment scenarios included consideration of cultural uses of fish, plants (fiddlehead ferns and medicinal plants), snapping turtles and wood ducks in exposure estimates. Findings led researchers to conclude that consumption rates of most animal species, except duck, carried a public health concern for mercury exposure. Consequently, the CDC issued a recommendation to limit consumption of Penobscot River fish and turtles, but not ducks or plant life. The study also found that the Penobscot River water, its sediments and drinking water from an underground aquifer showed no evidence of mutagenicity from the classes of organic compounds known to be cancer-causing or mutagenic.

MARYLAND

Partners: Maryland Department of the Environment (MDE), Montgomery County, City of Rockville

Challenge: Identifying the most cost-effective suite of stormwater best management practices (BMPs) to meet both local sediment total maximum daily loads (TMDLs) and downstream targets for Chesapeake Bay TMDL (ongoing)

Resource: Case study application of EPA's Watershed Management Optimization Support Tool (WMOST) version 3



"One of Maryland's greatest challenges, and opportunities, is to ensure its Phase I MS4's meet permit and TMDL restoration requirements in ways that are affordable and sustainable. This study, in a small urban watershed, is a cooperative effort among state, county and city governments and EPA to develop a balanced implementation strategy. EPA ORD's modeling tools used in this study have unique features such as stormwater BMP runoff reduction estimates and cost optimization modules to help us achieve environmental results, while maximizing savings for ratepayers." – MDE Secretary Ben Grumbles

The Maryland Department of the Environment (MDE) has identified the Cabin John Creek watershed in Montgomery County, MD as impaired by sediments, nutrients, bacteria, chlorides, sulfates and impacts to biological communities. Cabin John Creek drains to the Potomac River, part of the Chesapeake Bay watershed. To help address these impairments, MDE is providing guidance to local communities about applying cost-effective best management practices (BMPs) to meet regulatory targets set by the total maximum daily loads (TMDLs) for sediments.

EPA ORD is applying version 3 of EPA's Watershed Management Optimization Support Tool (WMOST) to the Cabin John Creek watershed to determine the most cost-effective suite of stormwater BMPs (including green infrastructure) for controlling sediment loading. Watershed managers are using the results of WMOST calculations to identify solutions that will meet both local sediment targets and downstream loading targets for total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) for the entire Chesapeake Bay watershed.

MASSACHUSETTS

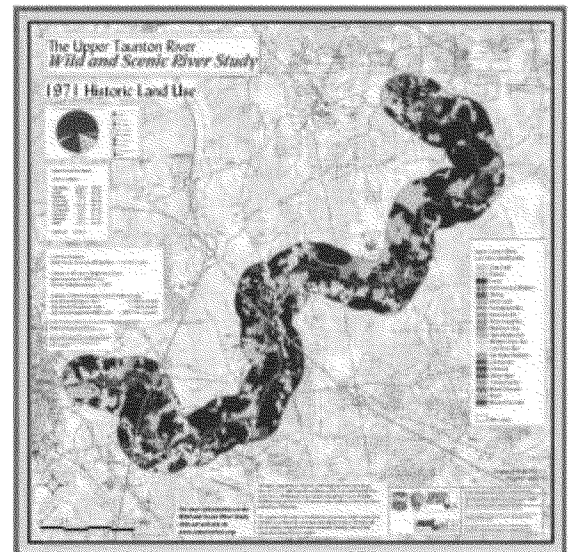
Partners: Manomet, Audubon, Nature Conservancy, Southeastern Regional Planning and Economic Development District (Tauton, MA), nine townships in upper Taunton River Watershed in response to recommendations from the state of Massachusetts

Challenge: Evaluate robust management practices to improve water quality, sustain water supply, and reduce flooding under varying weather regimes and projected landscape development using conservation and restoration of natural infrastructure and natural processes (ongoing)

Resource: Case study application of EPA's Watershed Management Optimization Support Tool (WMOST)

"Manomet is partnering with EPA ORD to apply the WMOST model in the Taunton River Watershed in southeastern Massachusetts. The WMOST analysis will provide insight on the nutrient pollution ramifications of different degrees of protection of the green infrastructure network identified by Manomet and project partners. Without the support of EPA ORD, the application of WMOST to quantify the value of the green infrastructure network would not have been possible." – Manomet, Senior Program Leader Climate Services Eric Walberg

The Taunton River in Massachusetts is a designated Scenic River with significant natural resources, but is located in a rapidly developing region with water supply issues and degrading water quality. The state of Massachusetts has recommended conservation objectives for the watershed that include creation of public forums on the economic value of purchasing (conservation) lands to control municipal budgets and the development of a land purchase priority system. Based on this recommendation, EPA ORD is assisting the non-governmental organization (NGO) Manomet with an application of the Watershed Management Optimization Support tool (WMOST), to evaluate costs and benefits of natural and nature-based green infrastructure in protecting property and drinking water quality. EPA ORD will also help communities in the upper Taunton by demonstrating a new version of WMOST designed to support consideration of multiple objectives. This will provide stakeholders information to evaluate tradeoffs. In addition, this case study is providing information that will be used by the NGOs and regional planning commission for training workshops on green infrastructure in surrounding communities.

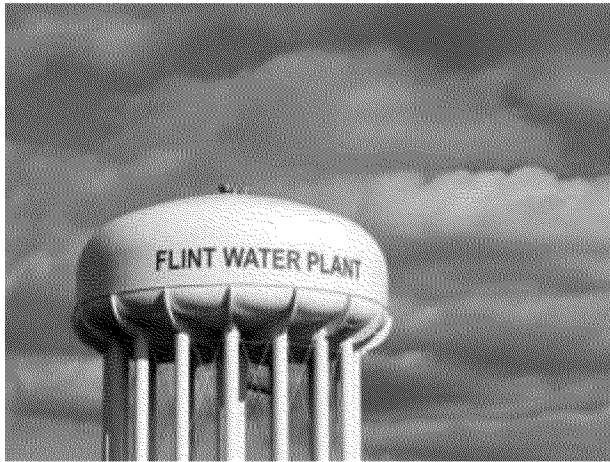


MICHIGAN

Partner: Michigan Department of Environmental Quality (DEQ), City of Flint

Challenge: High lead levels and other water quality challenges in the Flint water system (ongoing)

Resource: Technical support, computer modeling and sampling equipment



"The information that our EPA colleagues shared was critical to our understanding of water systems in Flint."

– Genesee County Health Department, Public Health Division Director Suzanne Cupal, MPH

In April 2014, the city of Flint, Michigan, switched from purchasing finished drinking water from the City of Detroit to treating raw water from the Flint River. For several reasons, the finished drinking water was corrosive following this change. As a result, the water stripped the protective mineral layer from pipes in the drinking water system and caused lead to leach from the pipes, increasing the lead levels in the water. In October 2015, Flint switched

back to purchasing finished water from Detroit, and EPA formed the Flint Safe Drinking Water Task Force to provide technical assistance to the City and State. In January 2016, EPA started a large-scale sampling effort in Flint for lead, water quality parameters, and chlorine residual throughout the distribution system.

EPA ORD scientists and engineers, in coordination with Region 5 and the Office of Water, provide technical support for the Flint drinking water response effort and the Flint Safe Drinking Water Task Force. The Task Force provides technical assistance to the Michigan DEQ and the City of Flint to inform decisions about a source of drinking water and to optimize corrosion control for the Flint system. EPA researchers reviewed the treatment history, corrosion control and water quality for the Flint water system and made treatment recommendations. They also provided sampling equipment and advice in the field on sampling strategies and developed a disinfectant residual monitoring plan to ensure that residual is maintained throughout the distribution system. Pipe loop rigs were built that incorporated lead pipes removed from Flint homes for real-time monitoring of lead and corrosion control assessment. In addition, an improved distribution system hydraulic model was built so the city now has a better understanding of the quality of the water moving through the system.

ORD researchers continue to support the City of Flint and are currently working on lead service line detection methodologies for identifying existing lead pipes, lead particle analysis and assessment, corrosion control treatment optimization studies for water source change using the pipe rigs, lead source/release diagnostic studies, and pipe analyses for long-term treatment assessment and mechanisms of lead and other metals release (<https://www.epa.gov/flint/flint-drinking-water-technical-support-team>).

MINNESOTA

Partner: Minnesota Pollution Control Agency (MPCA)

Challenge: Addressing Beneficial Use Impairments through tracking and remediation of bioaccumulating contaminants (ongoing)

Resource: Modeling bioaccumulation of PCBs and mercury in fish



“EPA ORD’s Mid-Continent Ecology Division has been instrumental in providing data, analytical expertise and guidance to support MPCA’s efforts to remove Beneficial Use Impairments (BUI’s) in the St. Louis River Area of Concern (AOC) in Duluth, MN and Superior, WI. This AOC is the largest and most complex of the 43 legacy pollution sites surrounding

the Great Lakes in the U.S. and Canada. EPA’s work on aquatic macrophyte models, bioaccumulative compounds in fish tissue, benthic invertebrate communities and spatial data sets has accelerated the implementation of our plan to complete all project work in the AOC by 2020 so that BUI’s can be removed by the target date of 2025.” – MPCA Commissioner John Stine

The St. Louis River is listed as a Great Lakes Area of Concern (AOC) under the Great Lakes Water Quality Agreement of 1987. This AOC has several Beneficial Use Impairments including loss of fish and wildlife habitat, excess loadings of sediment and nutrients, degradation of aquatic invertebrate communities (benthos), and restrictions on fish and wildlife consumption. MPCA conveyed a need to identify improvements and advance progress toward removing use impairments and eventual AOC delisting.

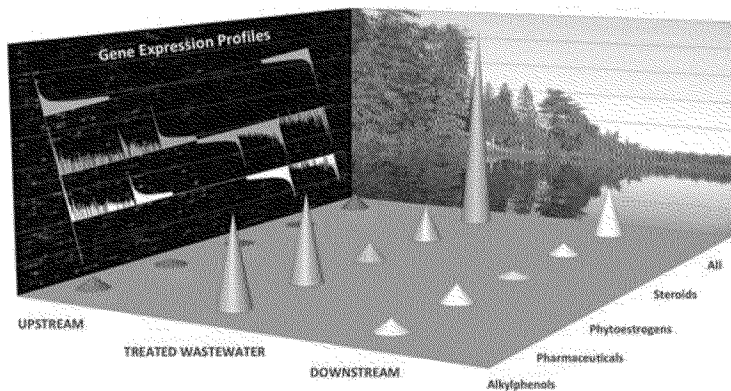
One of the critical impairments identified for this AOC is restriction of fish and wildlife consumption. Both Minnesota and Wisconsin have posted fish consumption advisories for the St. Louis River because fish have elevated mercury and polychlorinated biphenyl (PCBs) concentrations. Bioaccumulation of dioxins and furans in the Thomson and Scanlon reservoirs are also a concern for fish, wildlife and human health. MPCA identified the need to develop approaches to establish remediation targets for these and other bioaccumulating contaminants, and monitoring designs to track progress after sediment remediation has occurred.

EPA ORD researchers worked with state agency staff to develop a geospatial, habitat-based model of fish bioaccumulation of PCBs to help determine the extent of PCB contamination in the AOC, screen for contamination “hot spots,” and develop monitoring plans for future assessments. ORD researchers also led a multi-federal/state agency team to apply cutting-edge chemical tracers to identify the source and pathways of mercury contamination in the AOC. The tracers are being applied to determine the role of legacy mercury contamination in the AOC, and aid in establishing a mercury-specific remedial target. Finally, an approach to determine the effectiveness of remediation that was developed in other Great Lakes AOCs was brought to the Thomson and Scanlon reservoirs to aid state agencies in implementing and tracking the success of a proposed remediation of dioxins and furans in the reservoir sediments.

Partners: Minnesota Pollution Control Agency (MPCA), Western Lake Superior Sanitary District

Challenge: Complexity of waste water treatment plant (WWTP) effluents and lack of available water quality guidelines or reference values for many of the chemicals (ongoing)

Resource: Biological effects-based monitoring of WWTP effluents using new science tools in collaboration with the St. Cloud State University, the University of St. Thomas, the National Park Service and USGS Toxic Substances Hydrology Program



"The information generated through this collaborative work will help MPCA and local wastewater treatment facilities better address the contaminants in sewage treatment discharges. Managing impacts of chemicals in surface waters is especially important for MPCA as Minnesotans highly value lakes and streams."

— MPCA Commissioner John Linc Stine

While wastewater treatment infrastructure has been critical for the improvement of water

quality nationwide, effluent from waste water treatment plants (WWTPs) often represents a highly complex soup of chemical contaminants whose composition can vary daily and seasonally with human inputs as well as plant operations. Due to both their complexity and the lack of available water quality guidelines or reference values for many of the chemicals found in WWTP effluents, these sources pose a challenge for determining what biological impacts these effluents may cause, which chemicals may be driving those responses, and where and how to best allocate limited resources available for monitoring and management.

In collaboration with partners at the Western Lake Superior Sanitary District in Duluth, Minnesota, MPCA and other federal and academic partners, EPA ORD studied WWTP effluents discharging into a diversity of surface waters across Minnesota, ranging from urban and agriculture influenced watersheds, to large Great Lakes tributary streams, to a highly pristine national scenic waterway. The group employed novel tools akin to clinical diagnostic tests to look at fish caged in effluent impacted waters, and to estimate and measure both potential and observed biological effects of tens to hundreds of chemicals. By comparing the observed effects of these complex mixtures to expected effects housed in on-line databases, the scientists can better identify which chemicals and biological effects might be of greatest concern, and also identify whether unknown constituents may be contributing significantly to the responses. With this information, decision makers in Minnesota will be able to strategically target follow up investigations that can generate solutions to these challenges.

Partner: Minnesota Pollution Control Agency (MPCA)

Challenge: Development of an updated sulfate standard (completed)

Resource: Technical support to the state by expert consultation and peer review

"MPCA values the scientific expertise and partnership of EPA ORD, as we have worked to understand the complex physical, chemical and biological relationships that impact wild rice growth in Minnesota's lakes, stream and wetlands. By cooperating with the ORD's Mid-Continent Ecology Division and other scientific experts, the MPCA has developed ground-breaking improvements in our understanding of these relationships." – MPCA Commissioner John Stine

EPA ORD scientists supported an ongoing effort in Minnesota to better understand and address the effects of sulfate and other substances on wild rice, which is an important component of many of Minnesota's lake and stream ecosystems, and a highly valuable economic and cultural resource for many state residents. ORD researchers consulted with lead scientists from MPCA on both the original study protocol and the technical aspects of the study, and then on the analysis and interpretation of the resulting data. ORD also consulted with EPA Region 5 on aspects of sulfate water quality standards. These improved understandings will help decision makers protect Minnesota's wild rice waters. MPCA is in the process of amending the water quality sulfate standard to protect wild rice, and in 2017 MPCA will be publishing proposed amendments and providing public comment opportunities.

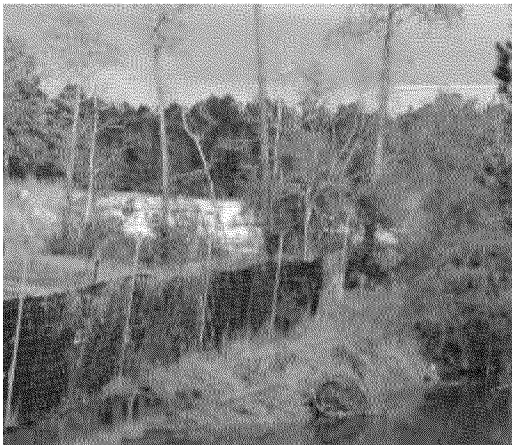


MISSISSIPPI

Partners: Mississippi Department of Environmental Quality (DEQ), Turkey Creek Community Steering Committee

Challenge: Multiple sources of fecal contamination (ongoing)

Resource: Fecal bacterial and viral indicators for identification of pollution sources



“Along with these efforts in Turkey Creek, Mississippi DEQ feels very fortunate to have benefited from our ongoing partnership with EPA’s Gulf of Mexico Program and ORD’s Gulf Ecology Division. As with all successful partnerships, we attribute these successes to the dedicated staff at our respective agencies along with the community leaders and their commitment to collaboration and communication throughout the project. We look forward to future opportunities for successful collaboration.” – Mississippi DEQ, Field Services Division Chief Doug Upton

Turkey Creek in Gulfport, Mississippi, is listed as impaired due to fecal contamination under the Clean Water Act. Pollution control measures are only effective if the sources are identified. In 2007, the Mississippi DEQ included three monitoring locations on Turkey Creek as part of an Ambient Recreational Monitoring Network. As this contamination issue has persisted for some time, EPA ORD began assisting in 2016 by collecting samples at the monitoring stations and employing novel viral and community microbiology techniques to compare with standard bacterial techniques.

These locations are sampled and evaluated for fecal coliform and *E. coli* during both the contact (May-October) and non-contact (November-April) seasons. In August 2011, the local community’s plans included the need to identify and mitigate all pollution sources for both Turkey Creek and Bayou Bernard and establish regular monitoring to ensure water quality.

EPA ORD scientists and partners are collaborating on research to identify the sources of fecal pollution in Turkey Creek, leveraging the current successful community citizens’ science bacterial monitoring program established by EPA’s Gulf of Mexico Program. Collaborators from the Gulf of Mexico Program are in regular communication with Mississippi DEQ. Through a monthly sampling scheme, fecal sources are being identified through characterization of viral genotypes and microbial communities in the water column and sediment. The project also evaluates land use, stream hydrology and urban sewage treatment in the landscape for the identification of point and non-point pollution sources. Data from this project will be shared to better inform decisions made by Mississippi DEQ and the local Turkey Creek Steering Committee to control fecal-contamination in Turkey Creek.

Partners: Mississippi Department of Marine Resources (DMR), Grand Bay National Estuarine Research Reserve (GBNERR)

Challenge: Better understanding acute and chronic effects of industrial spills on ecosystem health in a coastal reserve (ongoing)

Resource: Analysis of ten years of monitoring data to describe water quality changes from industrial spills, in collaboration with the National Oceanic and Atmospheric Administration (NOAA)



“When there’s an industrial spill, we want to be able to respond appropriately. Analyzing effects of prior spills on things we measure in our long-term water quality and nutrient monitoring program helps us plan for such situations by understanding the past. ORD staff has been incredibly helpful in analyzing the data – bringing both statistical and software expertise to the project. Through the process, they’ve helped us get a better idea of how to analyze and interpret our long-term monitoring data. This is also helping with other data analyses and will be used by other state agencies.” – Mississippi DMR GBNERR Monitoring Coordinator Kimberly Cressman

Grand Bay is part of the National Estuarine Research Reserve System (GBNERR) established as a federal partnership with the Mississippi DMR to address long-term research, monitoring, education and stewardship goals. The reserve includes 18,400 acres of protected areas that cover several coastal habitats including pine savannas, salt marshes, seagrass meadows and oyster reefs. Researchers at GBNERR work collaboratively to advance science-based management and appreciation of the reserve’s unique resources. Although GBNERR is relatively pristine, industrial activities have negatively affected the health of the bay. One of the largest fertilizer production facilities in Mississippi is located in the nearby city of Pascagoula. Extreme weather caused two spill events in 2004 and 2011. Highly acidic and phosphorus-rich wastewater entered GBNERR, causing dramatic changes in water quality and observed fish kills. Understanding the immediate and potentially long-term effects of these events is a priority for effective management of GBNERR.

Understanding long-term changes in water quality is critical to describing historical impacts and developing expectations of future changes of the ecosystem health of GBNERR. Research staff at GBNERR have been collecting routine monitoring data at several locations since 2004. After attending an EPA ORD workshop on time-series analysis, GBNERR staff initiated a collaborative effort to describe the response of nutrient parameters in GBNERR in relation to acute and chronic effects of each spill event, as well as spatial changes in these parameters among the monitoring sites. Previous studies have been limited in the amount and quality of data used to describe such spill events. Results from this analysis provide critical information on estuarine response to industrial impacts—most estuaries are nitrogen-limited so the effects of phosphorus inputs are not well understood. This collaborative work not only addresses a critical research gap, but also describes potential changes in GBNERR water quality that can guide more effective management of this unique and valued ecosystem.

MISSOURI

Partner: Missouri Department of Natural Resources (DNR); City of Kansas City

Challenge: Defensible models to reduce sewer overflows and improve regional water quality in a cost effective manner (completed)

Resource: Storm Water Management Model



"States are focusing on ways to address storm water and tools like the Storm Water Management Model are essential to a successful outcome. This model makes analyses of best management practice options readily available. In addition, the climate adjustment addition helps cities reach sustainable solutions." – Missouri DNR Sara Parker Pauley (former director)

States and municipalities heavily use EPA ORD's Storm Water Management Model (SWMM) to model stormwater flows and the performance of water infrastructure in urban areas. SWMM's Climate Adjustment Tool can also be used to consider potential future changes in temperature and precipitation that

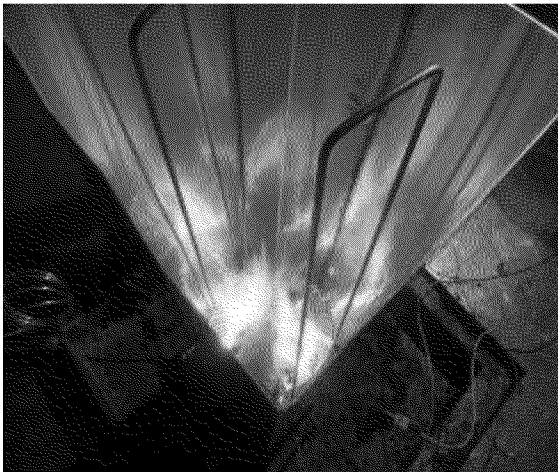
will influence the runoff volumes. SWMM is the engine for the basis of almost all consent decree and other future water infrastructure design. SWMM runoff and flow predictions are used for multi-billion dollar decisions for foreign, federal, state and municipal governments. The city of Kansas City, Missouri, designed its \$10 million, 100-acre Middle Blue River pilot on SWMM predictions, and the City will design its \$2 billion, 20-year consent decree based on its performance.

MONTANA

Partner: Montana Department of Environmental Quality (DEQ)

Challenge: Asbestos exposure following forest fires (completed)

Resource: Computer modeling in collaboration with the U.S. Forest Service



“The modeling results were used to scope and plan for the potential socio-political and management challenges resulting from a wildfire occurring in or threatening a portion of the Libby Asbestos Superfund Site. These results will also be used to assist the Montana DEQ in evaluating proposed remedies, and are important in informing local and Montana Department of Natural Resources and Conservation firefighters in developing response actions to protect firefighters and the citizens of Libby and the surrounding area.” – Montana DEQ, Remediation Division Lisa Dewitt

As noted above, Libby amphibole asbestos (LAA) has been found to co-occur with the vermiculite ore that was mined in Libby, Montana starting in the 1920s. Due to the presence of

asbestos, additional concerns have been raised about the potential for forest fires near the Libby Asbestos site to spread asbestos fibers, exposing firefighters and those living adjacent to the Libby site.

To address this potential health hazard, EPA ORD, in collaboration with Region 8 (Mountains and Plains), provided technical support to Montana DEQ in assessing the health risks associated with potential forest fires near the Libby Asbestos site in Montana. Specifically, ORD conducted experiments to understand the potential asbestos emissions, and Region 8 used these data in a model to assess whether these emissions would result in potential exposures. To obtain emissions data, ORD first burned forest floor material from a portion of the Libby Asbestos site, simulating a forest fire. During these simulated burns, particulate matter and gaseous emissions were measured and samples of the ash were analyzed to determine whether these samples contained asbestos. These data suggested that only a small fraction of the asbestos in the forest floor material was released into the gas phase. EPA Region 8 then used these data, along with direct measurements of asbestos in the forest floor at the Libby site, and estimated combustion and meteorological conditions in a model to estimate potential asbestos exposures under various scenarios. Because of these modeling efforts, EPA was then able to provide Montana DEQ with the range of potential exposures for these scenarios. In addition, EPA is now able to model forest fires when they do occur to more accurately estimate exposures and health risks to firefighters and to the surrounding communities.

Partners: Montana Department of Environmental Quality (DEQ)

Challenge: Addressing human health risks of exposure to Libby amphibole asbestos (completed)

Resource: IRIS assessment



“EPA ORD establishing the toxicity of the Libby amphibole asbestos (LAA) was key to completing the multipathway risk analysis that was necessary for the remedial action to move forward and provide confidence for the public that a decade of EPA removal actions was protective.” – Montana DEQ, Remediation Division Lisa Dewitt

Libby amphibole asbestos (LAA) has been found to co-occur with the vermiculite ore that was mined in Libby, Montana starting in the 1920s. When the mining and milling operations were active, residents of the Libby region were exposed to high air concentrations of LAA. Local clinics began to observe incidences of respiratory disease in the Libby area that were much higher than the national average for these asbestos-related diseases. After mining and milling operations ceased, exposures still occurred from soils and vermiculite home insulation contaminated with LAA; from roads, driveways and recreational areas where mine tailings containing LAA had been used; and from former vermiculite processing facilities located in Libby. In 2002, the Libby mining and milling operations site (Libby Asbestos) was placed on the Superfund National Priorities List.

The community had great concerns about the risks posed by the asbestos contamination in the town, with a significant portion of residents concerned that the particular kind of asbestos in Libby was more toxic than other forms of asbestos. In 2009, EPA announced that a public health emergency existed at the Libby asbestos site – this was the first time EPA had made a determination under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that conditions at a site constituted a public health emergency.

EPA ORD, in collaboration with Region 8 (Mountains and Plains), developed an Integrated Risk Information System (IRIS) assessment of the asbestos mixture found in Libby (referred to as Libby amphibole asbestos). Based on epidemiological analyses of workers exposed to LAA, the assessment concluded that inhalation exposure to LAA could lead to thickening of the membranes that envelop the lungs, which could decrease lung function. The assessment was able to identify a level of exposure that, over a lifetime, would be unlikely to cause such effects on the lung membranes. This was the first quantitative toxicity estimate of adverse non-cancer health effects for any type of asbestos. The assessment also established that the asbestos found in Libby produced cancer, and importantly for the community, was able to show it was similar in potency to other forms of asbestos.

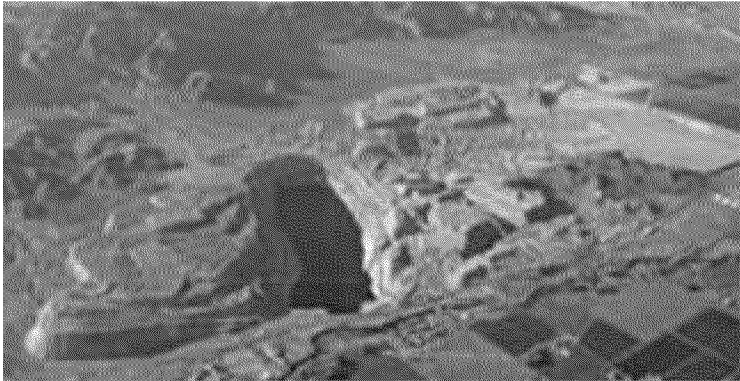
With the IRIS assessment of LAA, along with site-specific exposure data, decisions could be made to protect human health and to address community concerns about the toxicity of the specific form of asbestos found in their area. EPA’s Libby Superfund Site Human Health Risk Assessment, using the IRIS assessment, showed that the cleanup actions EPA has taken since 1999 have reduced LAA exposures and risks at the Libby Asbestos site. The asbestos ambient air concentrations there today are about 100,000 times lower than when mine and processing facilities were in operation, making today’s air quality in Libby similar to other Montana cities.

NEVADA

Partners: Nevada Division of Environmental Protection (DEP)

Challenge: Groundwater characterization and remediation at the Anaconda Mine Site (Lyon County) (completed)

Resource: Technical assistance and review of groundwater background conditions and groundwater characterization to assess the amount and type of groundwater contamination



“ORD’s technical assistance has been essential in characterizing the complex hydrogeological conditions and extent of groundwater contamination at the Anaconda Mine Site, setting the stage for evaluation of remedial options.” — Nevada DEP Administrator Greg Lovato

The Anaconda Mine Site has uranium and sulfate groundwater contamination related to previous copper ore mining. Hydrology at the

Anaconda Mine Site is complex and subject to significant uncertainty, particularly with respect to the effects of local hydrology on long-term contaminant migration. Establishing background concentrations of uranium and sulfate in groundwater are also critical to understanding the extent and magnitude of groundwater contamination. Groundwater modeling provides a useful tool for better understanding current conditions and potential remedial options, but the performance of any selected remediation strategy must ultimately be determined by a properly designed performance monitoring network.

Groundwater modeling of this site has the potential to reduce the cost of monitoring by helping to pinpoint where monitoring wells are most needed. EPA ORD has provided technical assistance on and reviews of groundwater characterization and modeling efforts, as well as technical analyses that will be used to evaluate possible remediation options. Nevada DEP Abandoned Mine Lands Program, in conjunction with EPA Region 9 (Pacific Southwest), is using the analyses provided by ORD to help design both better remediation strategies and better monitoring systems for the abandoned mine complex.

NEW HAMPSHIRE

Partners: New Hampshire Department of Environmental Services (NHDES)

Challenge: Stream assessment integration and efficiency (completed)

Resource: Probabilistic survey designs integrating national and state reporting requirements



"The partnership between EPA ORD and NHDES on the national stream assessments has created synergies that allow both organizations to meet their respective goals. Using each organization's strengths – NH DES' familiarity with streams in the state and EPA's skill with survey sampling design – the result is far greater than either could achieve alone." – NHDES Water Pollution Division, Watershed Management Bureau Biomonitoring Program Andy Chapman

The NHDES Water Quality Assessment Program is responsible for reporting on the quality of the streams in New Hampshire under the Clean Water Act. It is impossible to sample every stream, so NHDES sought a means to subsample streams in such a way that was representative of all state streams. EPA researchers have developed a statistically robust protocol for doing just that. EPA ORD scientists have developed a probabilistic survey design that ensures that results from sampled locations are representative of the condition of all streams in the survey area. This strategy has been incorporated into the National Aquatic Resources Surveys (NARS), which includes national-scale assessments of rivers and streams, lakes, coastal zones and wetlands.

NHDES assembled a geographic data layer that identifies all streams within the state that must be assessed. They requested that EPA ORD integrate this stream data layer into the NARS National Rivers and Stream Assessment (NRSA). Using their stream network instead of the NRSA network enables the state to use the results of the state survey for the national dataset. Consequently, the state will conduct a state-level survey design for 2018-22 and integrate it with NRSA. This integration of the state and national survey designs is a cost-effective option for participating in NRSA while also meeting state assessment requirements.

In 2004, EPA partnered with states to provide national and regional level assessments for Clean Water Act reporting. EPA ORD has assisted 53 different states, tribes and territories since 2012 to develop sample survey designs and biological, chemical and physical habitat indicators. The survey designs provide statistical rigor for small sample sizes, which allow states to report on more of their waterbodies than previously possible.

NEW JERSEY

Partner: New Jersey Department of Environmental Protection (DEP)

Challenge: PFAS contamination (ongoing)

Resource: Water, soil and sediment analyses



“EPA ORD’s studies have provided critical information needed to develop PFAS human health risk assessments. In particular, we appreciate your foresight in initiating studies of PFNA several years before it was widely recognized as a potential concern. Also, we especially thank you for your ongoing willingness to share your knowledge of PFCs (perfluorinated compounds) in general, to answer all of our questions about your studies, and to continue working with us on identifying PFAS sources.” – New Jersey DEP Research and Environmental Health, Division of Science, Gloria B. Post, PhD, DABT

A concern of New Jersey DEP is the ongoing presence of poly- and perfluoroalkyl substances (PFAS) in the drinking water resources of southwestern New Jersey. New Jersey DEP reached out to EPA ORD when they were faced with relatively high contaminant levels of a specific PFAS (perfluorononanoic acid, PFNA). New Jersey DEP continues to study the potential routes PFAS might be following in finding its way into these water resources. The chief questions are where the contamination is originating and whether it is getting into the water through direct discharge or through the air. Previous analysis of water samples suggests that by looking at the ratios of different PFAS, it might be possible to identify a source signature that could help determine the contaminant’s origin. The goals of this study are to confirm that PFAS contamination is occurring, establish specific PFAS source signatures, and evaluate the potential for impacts due to air deposition.

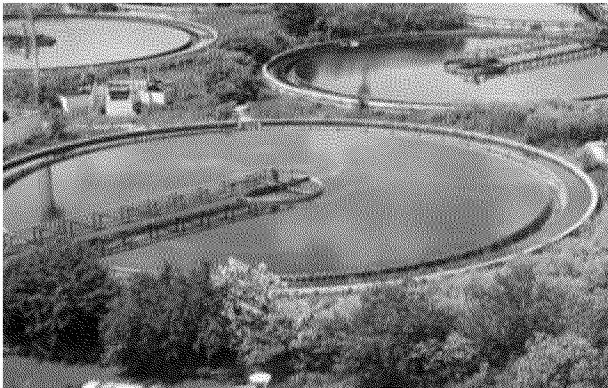
New Jersey DEP has requested that ORD continue to work with them to analyze water, sediment and soil samples for PFAS and their byproducts. In addition, ORD will collaborate with New Jersey DEP to evaluate the data and summarize the study's findings in a joint publication.

NORTH CAROLINA

Partners: NC Department of Environmental Quality, City of Charlotte, City of Raleigh

Challenge: Acceptance of bio-contaminated wastewater by Publicly Owned Treatment Works (POTWs)

Resource: Technical support in the area of pathogens in wastewater infrastructure



“The question of how wastewater plants deal with bio-contaminated waste needs to be addressed before a potential health emergency surfaces. EPA’s proactive work to assist wastewater operators before the next emergency occurs is not only prudent, but critical in order to protect public health.” – NC DEQ Assistant Secretary Sheila Holman

In October 2014, EPA held a forum on pathogens in wastewater infrastructure for state and POTW representatives. The forum focused on providing

recommendations, technical information and potential solutions to the wastewater industry, particularly for emergencies.

EPA is investigating data needs that, if filled, would assist wastewater plant operators in making decisions about whether and how to accept wastewater contaminated with pathogens (e.g. anthrax bacteria, Ebola virus) during an emergency. EPA is also in the process of performing research projects to address needs associated with POTW acceptance of wastewater potentially contaminated with pathogens.

The forum was organized around the following questions: How do we deal with wastewater contaminated with biological agents such as *Bacillus anthracis* or Ebola virus? What is needed/required for utilities to accept bio-contaminated wastewaters? What sorts of tests, protocols and regulatory guidance are needed? What is needed for permit authorities in NC to guide/allow utilities to accept these wastes? How should these (tests, protocols and regulatory guidance) be designed or implemented? Who should design and evaluate these? Are there other “simpler” tests and protocols? What is needed to address concerns and issues raised by the public, wastewater workers and operators? What are the data gaps and what type of research is needed?

As a result of this forum, EPA and the Water Environment Research Foundation held a national workshop on this topic in 2016. In turn, this led to several research projects being planned and implemented to address the key research gaps and needs brought up in the workshop.

Partners: NC Department of Environmental Quality (DEQ), Cape Fear Public Utility Authority, Town of Pittsboro, Fayetteville, NC State Highway and Public Works Commission

Challenge: Mapping PFAS levels across an entire river basin

Resource: Methods development and laboratory analyses

"We are extremely grateful for EPA ORD's work as we analyze these chemical compounds. EPA's analyses will be crucial to our efforts in protecting public health and the environment as we learn more about these emerging substances." – NC DEQ Assistant Secretary Sheila Holman



Because of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), which persist in the environment, their use began being phased out in 2006. In 2007, EPA ORD began a first-ever effort in the U.S. to map PFAS levels in an entire watershed, focusing on North Carolina's Cape Fear River Basin. This mapping effort demonstrated that there were multiple sources of many different PFAS throughout the basin, suggesting that since the basin is a major drinking water resource, it could potentially be responsible for human exposures to PFAS throughout the entire region. As part of this effort, EPA ORD also developed research based methods to measure PFAS in drinking water.

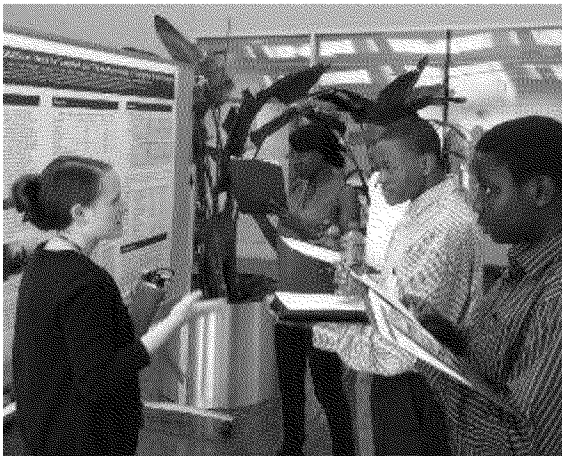
EPA ORD's PFAS research in the Cape Fear Basin has continued since the 2007 mapping effort, specifically focusing on continued tracking of PFAS in surface and drinking water samples while discovering the emergence of novel PFAS using high resolution mass spectrometry non-targeted analysis approaches. This work was highlighting the ongoing presence not only of many of the old, legacy PFAS compounds (such as PFOS/PFOA), but also of a suite of new PFAS (such as GenX) that came into production after the legacy PFAS were phased out. Most recently, ORD researchers showed conclusively that these new PFAS were present in the drinking water in Wilmington, NC. Based on the results of this and other work, the discharge of the chemicals into the watershed have been reduced resulting in significant reduction in exposures to these potentially hazardous chemicals.

Partners: US2020, Citizen Schools, Durham Public Schools, WakeEd Partnership, NC Science Mathematics and Technology Education Center, NC Science Festival, East Durham Children’s Initiative, North Carolina State University Kenan Fellows Program for Teacher Leadership

Challenge: Preparing the future environmental health workforce by providing STEM (science, technology, engineering and math) education, especially in K-12 schools with low-income populations (ongoing)

Resource: EPA Research Triangle Park’s (RTP) STEM Outreach Program

“The EPA STEM Outreach program not only has been a source of ideas for our own outreach program improvement but also serves as a model STEM outreach organization in the region, because of its impactful work in schools, museums, and on-site for students of all ages through speed mentoring, job shadowing, and hands-on STEM activities.” – The Research Triangle Foundation, US2020 STEM Outreach Program Manager Sarah Council Windsor



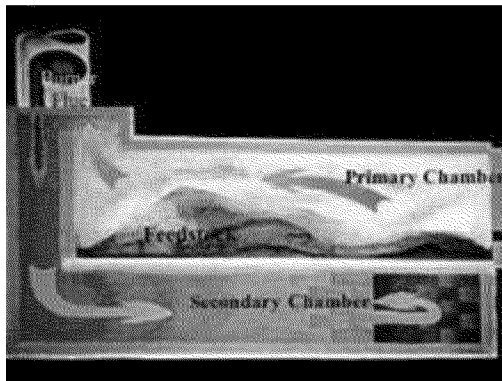
EPA RTP’s STEM Outreach program provides guest speakers and judges at science competitions, engages in impactful community partnerships, and provides hands-on educational programming for students and teachers in central NC and beyond. Most of the programming takes place in schools where at least 50 percent of students are on free or reduced lunch. The partners strive to inspire all students to consider STEM careers with the understanding that a diverse workforce is essential in addressing future environmental challenges.

EPA ORD develops hands-on activities and interactive discussions to engage student STEM learning and promote environmental awareness. Through participation in local, state and national education conferences, the partnership offers K-12 educator trainings that provide teachers with hands-on STEM strategies for their classrooms and shares the partnership model with other agencies and businesses. Additionally, EPA RTP’s campus hosts many educational events each year, including a week-long science workshop for high school students. EPA RTP was recently recognized as the US2020 Industry Partner of the Year for making a significant impact on RTP’s STEM community during the 2015-2016 school year by increasing access to STEM through focused volunteerism and on-site visits.

Partners: North Carolina Department of Agriculture and Consumer Services (NCDA&CS)

Challenge: Disposal of contaminated animal carcasses following an agricultural emergency (completed)

Resource: A prototype transportable gasifier technology for on-farm disposal of animal carcasses



"EPA has served as the coordination point for both the research and the response efforts related to mass disposal. Actual event response and field testing identify real problems that cannot be properly identified or solved when designing or modeling in an office. Environment, material handling, human factors, size and volumes of actual events must be experienced not perceived. EPA understands these challenges and continues to assist states and industry in attempting to solve the problems and bring workable technologies. Continued research and development efforts of this type are critical to assisting industry in their efforts to protect the food chain." – NCDA&CS Jim Howard (retired)

Agricultural emergencies, such as foreign animal disease outbreaks, could result in the need to dispose of many contaminated animal carcasses. The environmental impacts of carcass disposal are site-specific. Some technologies (e.g., burial) are not viable in areas with a high water table, such as North Carolina. Multiple disposal options are necessary. Gasification has the potential to be a technology for on-farm use, which reduces risk associated with transporting the carcasses to an off-site location (e.g., landfill, incinerator). It also has the potential to generate energy at agricultural sites during non-emergency times, and burns more cleanly thus requiring less pollution control equipment than conventional incineration.

As part of an interagency effort involving several federal agencies and the state of North Carolina, EPA built a prototype transportable gasifier intended to process 25 tons per day of carcasses (scalable to 200 tons per day) for on-farm disposal of animal carcasses. A demonstration was conducted to determine the feasibility of gasification for carcass disposal and to identify technical challenges and improvements to simplify and improve the gasifier as a mobile response tool. Past testing of the prototype demonstrated partial success, in that the transportability and rapid deployment requirements were met; however, the throughput of animal carcasses was approximately one-third of the intended capacity.

Significant modifications were made to various gasifier components, including the burner system, feed system, control system, power distribution and ash handling system, in order to increase its operating capacity to the rated design throughput. In September 2015, a series of tests were performed to evaluate the effectiveness of the design modifications at increasing the system's throughput, as well as to demonstrate the unit's ability to operate around the clock for an extended period of time. While the ash removal system and the system to move material across the bed failed during the tests, the new burner, feed, control and power distribution systems all functioned in an acceptable manner. The test and evaluation showed that improved alloys would be needed in some of the parts to achieve the desired results. EPA ORD's support has helped the NCDA&CS focus on which areas of the system require repair and additional modifications to achieve overall design goals.

OHIO

Partner: Ohio Environmental Protection Agency (EPA) and the City of Toledo

Challenge: Harmful algal bloom preventing access to drinking water (completed)

Resource: Innovative drinking water testing to help restore drinking water availability



“When we were faced with an emergency in Toledo last August due to cyanobacterial toxins detected in their treated drinking water, EPA ORD staff was a great partner and exceeded our expectations in understanding science and helping optimize treatment and restore safe drinking water to our residents.” – Ohio EPA Director Craig Butler

On August 2, 2014, the Mayor of Toledo, Ohio, issued a “Do Not Drink” order for the 500,000 people of the City of Toledo and neighboring communities because the water utility detected cyanobacterial toxins in their treated drinking water. The City’s drinking water source, Lake Erie, was experiencing a large

cyanobacterial harmful algal bloom at the time. Cyanobacteria, also known as blue-green algae, is particularly tricky because toxins are released from the bacteria when they are damaged, so boiling the water only makes the situation worse. The water ban set in motion a number of emergency actions, including Ohio Governor John Kasich declaring an emergency in the area, the mobilization of the Ohio National Guard to distribute bottled water, and the closure of hundreds of water dependent businesses in the Toledo metro area.

Working in conjunction with the City of Toledo, Ohio EPA officials immediately reached out to EPA ORD’s Cincinnati-based research laboratory for technical assistance. This laboratory is known as a world leader in the evaluation and development of innovative drinking water testing, monitoring, and treatment technologies. Ohio EPA asked for assistance with laboratory analyses for the presence of cyanobacterial toxins in their treated drinking water, and with identifying the optimal approach for controlling cyanobacterial toxins in the drinking water treatment plant and distribution system.

EPA ORD assembled a team of scientists and engineers to work throughout the weekend. The ORD team led discussions regarding sample handling and procedures and facilitated an agreement between Ohio EPA and the City of Toledo as to how they would collect and handle samples. Samples were handled per the protocol, and chemical analyses were run by an agreed upon procedure between Ohio EPA, the City of Toledo and EPA. Following the initial set of samples, the City of Toledo collected additional water samples throughout their treatment plant to assess the effectiveness of various treatment processes in reducing the cyanotoxin concentrations. The ORD team assessed sample results as the analyses were completed, and discussed what the results indicated about their current treatment processes with Ohio EPA and Toledo’s Department of Public Works. ORD scientists recommended treatment plant adjustments to further reduce cyanotoxin levels in the finished drinking water, and communicated the issues to local and state officials in real time during the event.

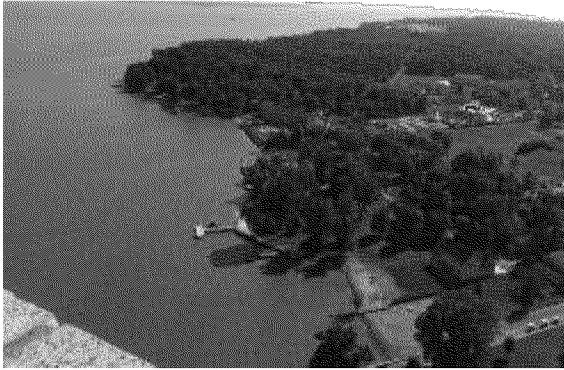
ORD’s efforts to produce timely and accurate results were critical for the Mayor of Toledo and the Governor of Ohio when making their decision to lift the “Do Not Drink” order two days later on August 4, restoring safe

drinking water to some half a million people. Soon after the order was lifted, EPA's Office of Water consulted with the ORD team and Ohio EPA to identify the lessons learned from the Toledo incident, particularly with regard to the sample preservation and handling procedures for cyanotoxin samples, identifying areas where improved guidance could be provided to U.S. drinking water systems performing cyanotoxin monitoring to assure samples are appropriately preserved for transport and prepared for analysis. The state of Ohio has long enjoyed a strong relationship with ORD.

Partners: Ohio Environmental Protection Agency (EPA) and public water utilities along Lake Erie

Challenge: Managing algal toxins in drinking water treatment plants (ongoing)

Resource: Algal toxin and water quality studies at drinking water treatment plants using Lake Erie as their source



"Ohio and EPA ORD continue to lead the nation in working with public water systems to ensure safe drinking water and minimize the threat of harmful algal blooms (HABs) and other emerging contaminants. Research that EPA ORD is doing is providing Ohio with immediate and practical information as we implement first in the nation rules on HABs, and we are grateful and fortunate and thankful for the collaboration on these important issues." – Ohio EPA Director Craig Butler

Increasingly, drinking water treatment plants are challenged by changes in the quality of their source waters and their aging treatment and distribution system infrastructure. Individually or in combination, factors such as decreasing water and financial resources, climate change, agricultural runoff, harmful algal blooms and landscape development increase the probability that algal toxins, pesticides, pharmaceuticals, personal care products, endocrine disrupting compounds and other contaminants of emerging concern will remain after treatment, ending up in people's drinking water.

In cooperation with public water utilities along Lake Erie, EPA ORD and Office of Water are conducting studies to improve our understanding of the propagation of contaminants of emerging concern (particularly cyanotoxins) through the drinking water treatment process, and to identify the best approaches for removing them. The recent sampling campaign provided a unique opportunity to characterize the development of Lake Erie's cyanobacterial bloom and its associated toxins at a high level of analytical detail. Researchers were able to provide utilities and regulators with treatment recommendations that will help them make better informed long-term decisions regarding the operation and modification of treatment processes to optimize removals.

OKLAHOMA

Partner: Oklahoma Department of Environmental Quality (DEQ)

Challenge: Fish kills and unknown contamination (completed)

Resource: Chemical composition analysis



"The ORD National Exposure Research Laboratory in Las Vegas was a valuable asset during Oklahoma DEQ's investigation into the Red River fish kills. This facility's expertise and analytical technologies assisted with researching potential causative agents related to these fish kills. In addition, I strongly support the mission of ORD to conduct valuable research that leads to improvements in the continued protection of public health and the environment." — Oklahoma DEQ Executive Director Scott Thompson

Between 2011 and 2013 there were several incidents of concern in the Red River watershed and Red Creek. There were four fish kills with unknown contaminants present in the water, and stray gas bubbling between fish kill events. Oklahoma DEQ requested EPA ORD assistance in identifying the unknown contaminants, and the source of the indeterminate stray gas.

EPA ORD scientists, in collaboration with Region 6 (South Central U.S.) set out to use state-of-the-art analytical tools to identify the contaminants, and to oversee an isotopic analysis of the gases sampled by a private company.

Through these techniques, ORD was able to make conditional chemical assignments of the contaminants and help determine that the stray gases were from a biogenic (natural) source. This assistance provided information to Oklahoma DEQ to assist in understanding and managing these incidents.

Partners: Oklahoma Department of Environmental Quality (DEQ)

Challenge: Evaluation of groundwater and surface water interactions at the Oklahoma Refining Co. Superfund site (ongoing)

Resource: Technical evaluation of remediation plans for the site



“EPA ORD provided concrete recommendations on data acquisition that have been incorporated into the ongoing investigation at the refinery. This access to experts really augments our ability to focus our resources to obtain the right information to support decision making.” – Oklahoma DEQ Executive Director Scott Thompson

The Oklahoma Refining Co. Superfund site is located in Cyril, Oklahoma. Gladys Creek adjoins the site along its northern and eastern borders. The 160-acre abandoned site, which was operated by several different owners as a refinery until 1984,

had generated wastes in approximately 50 impoundments (many unlined) and several buried waste areas. Shallow groundwater beneath the site flows away from the Cyril community and discharges into Gladys Creek. Approximately 1,600 people on public or private drinking water wells live within three miles of the site, with the closest well (private) within 1000 feet of the site.

Site operations contaminated soil, sediment, surface water and groundwater with polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and metals. Wastes had been placed in surface pits on the refinery property, and wastewater had been sent through an oil-water separator to remove oils and then treated in a series of surface impoundments. Treated water from the surface impoundments was discharged into Gladys Creek.

Cleanup of impoundments and waste sources was conducted between 1996 and 2001 on the southern portion of the site; most removal activities were completed in 2006 on the northern site. The remaining work, including the piece that EPA ORD helped with, includes groundwater, surface water, north side soil, and sediments.

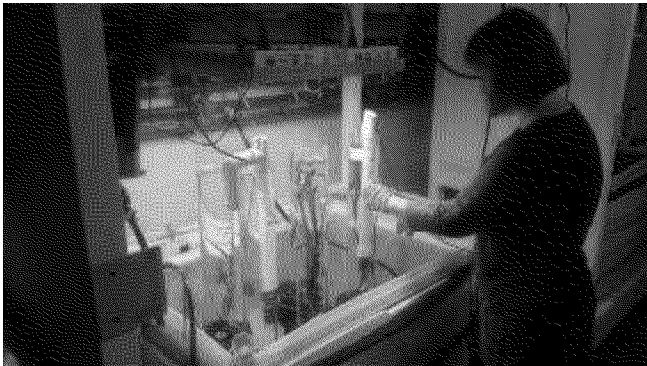
Previous site investigations provided extensive information on contaminant concentrations in groundwater, surface water, soil and sediments. This information has indicated where contaminants are found and where they exceed the relevant standards. However, an estimation of the mass flux of contaminants in either groundwater or surface water is necessary to determine the magnitude, rate and significance of adverse impacts on Gladys Creek and to evaluate what actions need to be taken regarding those impacts. The strategy to conduct this effort consists of identifying all major routes of groundwater discharge into Gladys Creek, quantifying groundwater and surface water discharge, estimating the contaminant mass flux in the surface water and groundwater, and evaluating the overall hydrology of the Gladys Creek watershed. ORD has provided technical review comments to the state and EPA Region 6 (South Central U.S.) for the *Plan Development to Evaluate the Impacts of the Ground-Water/Surface Water Interactions on Contaminant Migration at the Oklahoma Refining Company Superfund Site, Cyril, Oklahoma*. It is anticipated that this information provided by ORD researchers will assist Oklahoma DEQ in developing a remedial design for the remainder of the site.

OREGON

Partner: Oregon Department of Fish and Wildlife (DFW)

Challenge: Acidification in estuaries harming clam and crab fisheries (ongoing)

Resource: Ocean acidification research



“The expertise of the scientists at the Newport USEPA lab has been valuable as we evaluate how to improve monitoring of ocean acidification-related parameters and the value of seagrasses in buffering the effects of ocean acidification. Oregon’s shellfish aquaculture industry – and likely our wild marine species – are at risk from current ocean conditions, which are projected to become more corrosive over the next several decades.” – Oregon DFW, Marine Resources Program Manager Caren Braby

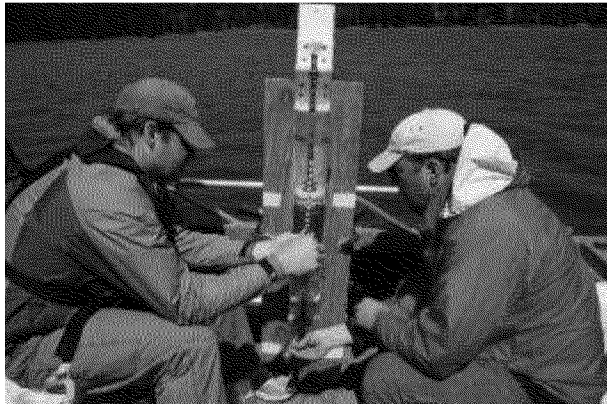
Increasing acidification of offshore ocean waters has harmed the oyster aquaculture industry in Oregon and threatens the state’s recreational and commercial fisheries for bay clams and Dungeness crabs. Governors of California, Oregon and Washington have joined with stakeholders through the Pacific Coast Collaborative to develop coordinated solutions to address the adverse effects of ocean acidification. In Oregon, the Oregon Coast Ocean Acidification and Hypoxia Workgroup formed to advance recommendations from the Collaborative. This workgroup, led by the Oregon DFW, includes representatives from Oregon Department of Environmental Quality, Oregon Department of Agriculture, EPA ORD, Lower Columbia River Estuary Partnership, Tillamook Estuaries Partnership, several tribes and watershed councils, the oyster aquaculture industry and universities.

In addition to participating in the interagency workgroup, ORD scientists are conducting research on the contribution of excess nutrients to acidification of estuarine waters, methods to distinguish human from natural sources of nutrients in estuaries, and the use of seagrass meadows as a method to reduce the effects of acidification to shellfish. The research is being conducted at ORD’s Pacific Coastal Ecology Laboratory in Newport and in Tillamook Bay – site of Oregon’s largest inshore shellfisheries. The results of this research will provide state agencies with tools to reduce the causes and effects of acidification in Pacific Northwest estuaries, thereby enhancing the environment and economies that depend on the shellfisheries.

Partners: Oregon Department of Environmental Quality (DEQ)

Challenge: Determine the influence of water level fluctuations on the seasonal production of methyl mercury in the Cottage Grove Reservoir (completed, but continued interactions)

Resources: Technical Investigation to help reduce methyl mercury levels



"I think this is valuable information for understanding potential methyl mercury loading contributions and methylation mechanisms related to water level fluctuations in Cottage Grove Reservoir. Looking ahead, this study suggests some potential considerations related to reservoir flow management that could help mitigate mercury methylation potential." – Oregon DEQ, Water Quality Monitoring Manager Aaron Borisenko

The Cottage Grove Reservoir located south of the Historic Black Butte Superfund Site has received historical and ongoing loading of mercury and transport of contaminated

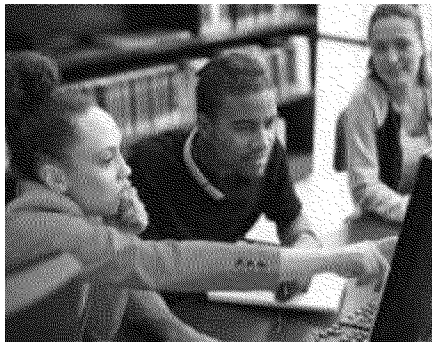
mercury sediments resulting in strict fish consumption advisories. Cottage Grove Reservoir operates as a flood control reservoir, and lower water levels during the fall and winter expose 60-80 percent of the reservoir sediments.

EPA ORD researchers designed an investigation at Cottage Grove to determine whether the seasonal exposure of reservoir sediments was contributing to the elevated level of methyl mercury within the reservoir water column. Results from the investigation identified that the seasonal lowering of the water level corresponded with increased production of methyl mercury in sediments that were exposed to the atmosphere. Currently, discussions for altering reservoir management strategies to control seasonal production of methyl mercury are underway. By lowering the loading of mercury to the reservoir, Oregon DEQ hopes to benefit communities that catch and eat fish.

Partner: Multnomah County

Challenge: Help communities identify local environmental issues (completed)

Resource: EPA's Community-Focused Exposure and Risk Screening Tool (C-FERST) and technical support



"Environmental consultants and business owners have the means to conduct environmental assessments but communities often don't. C-FERST changes that paradigm by making information about Brownfields (former commercial or industrial sites) accessible, thus placing decision making back into the hands of communities. It allows them to leverage resources that turn sites like Brownfields into something good for the community. What is powerful about C-FERST is that it advances EPA's responsibility to the public by taking public record and technical EPA documents and making them accessible for communities." – Multnomah County's Senior Program Specialist Matthew Hoffman

EPA's Community-Focused Exposure and Risk Screening Tool (C-FERST) is an online tool that helps communities identify environmental issues around them, learn about these issues, and then explore ways to reduce their health risks.

Officials from Multnomah County and the nonprofit organization, Groundwork Portland, used C-FERST to identify brownfields in their area and determine possible uses for these properties. The partners used C-FERST to conduct a community livability study assessing transit accessibility, food retail resources, and other issues as part of a neighborhood redevelopment plan in the county.

Students from Concordia University used C-FERST to conduct a children's health and wellness study in Portland. Students used the tool's community data to identify potential sources of social and environmental stress, including exposure to diesel pollution, poverty and access to medical care. Recommendations from their assessment were presented to community and government representatives.

Partners: Oregon Department of Environmental Quality (DEQ); Oregon Department of Agriculture

Challenge: Improve surface and groundwater nitrate contamination from agriculture (completed)

Resource: Collaborating with farmers to assess the effectiveness of fertilizer best management practices



“EPA ORD scientists have made significant contributions to the monitoring program in the southern Willamette Valley Groundwater Management Area. Their technical expertise has enhanced analyses of complex hydrological systems, as well as informed Oregon DEQ synthesis of multi-scale factors impacting nitrate concentrations in the southern Willamette Valley.” – Oregon DEQ Joni Hammond (former acting director)

Groundwater nitrate contamination affects thousands of households in the Southern Willamette Valley Groundwater Management Area in Oregon. To reduce non-point source loading of nitrogen to

groundwater and surface water, successful approaches are needed within affected communities to integrate science, outreach and management efforts. A partnership was formed that brings together commercial farmers, Oregon Department of Agriculture, soil and water conservation districts and EPA to assess the current state of groundwater in the Valley, and to evaluate best management practices (BMPs) in fertilizer management.

In this collaborative project, scientists measured nitrate leaching from 15 fields in the Valley. They shared the data with farmers and discussed BMPs for fertilizer application that would reduce the leaching. Farmers have instituted some of these BMPs on their fields, and are now seeing positive results for nutrient use efficiency and less contamination.

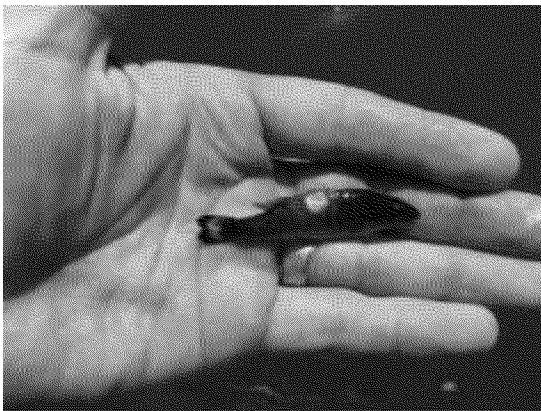
In addition, EPA ORD scientists have provided stable isotopic analyses to identify the causes of high temporal nutrient variability within local wells. These efforts have helped illuminate complex groundwater-surface water interactions and greatly improved Oregon DEQ’s monitoring program for the groundwater management area. ORD efforts helped to reduce potential new inputs of nitrate into the groundwater system and understand the complex dynamics of groundwater in general.

PENNSYLVANIA

Partner: Pennsylvania Department of Environmental Protection (PA DEP)

Challenge: Wide-spread freshwater fish disease (completed)

Resource: Causal Analysis/Diagnosis Decision Information System (CADDIS)



"I am confident that our science-based partnership with EPA ORD and the Pennsylvania Fish and Boat Commission will help us determine the causes of impacts to aquatic health in the Susquehanna. Science guides our work in assessing the overall health of the river, and in partnership with these agencies, we will be able to create a strategy that matches our challenges to conserve and protect this river, which is important to the recreational vitality and economic prosperity of Pennsylvania."
 – PA DEP John Quigley (former secretary)

Unusual mortality events and outbreaks of disease have been observed annually in young-of-the-year Smallmouth Bass in the mid to lower Susquehanna River since 2005, resulting in poor recruitment of juvenile fish into the adult population. The Susquehanna River Smallmouth Bass Technical Committee, including representatives from PA DEP and the Pennsylvania Fish and Boat Commission (PFBC), was formed in 2007 to characterize the potential causes of the problems. Numerous water-quality and fish health variables were evaluated, but no definitive associations emerged. Additional research and monitoring efforts continued, and in 2012 PA DEP initiated a large study of the river. In 2014, PA DEP and its partners looked to EPA ORD's expertise and innovative tool, the Causal Analysis/Diagnosis Decision Information System (CADDIS), to help organize and synthesize the data.

EPA assisted PA DEP and its partners in implementing the CADDIS causal assessment process, providing a means to utilize the data collected to date and winnow the long list of hypothesized causes of the poor recruitment of Smallmouth Bass. Candidate causes evaluated included abiotic stressors such as high flows, low dissolved oxygen, high pH, and toxicity from exposure to ammonia or toxic chemicals. Biotic candidate causes included food quality changes from non-native species and cyanobacteria. Diseases caused by pathogens or parasites were considered, as well as the possibility that stressors have increased Smallmouth Bass susceptibility to disease. Over 50 worksheets, comprising 400 pages, that described data collections and analyses were developed and evaluated during the course of assessment.

Pathogens and parasites were identified as likely contributors to the problem: disease prevalence was strongly and negatively correlated with survival of juvenile fish. Endocrine disruptors and herbicides were also judged to be likely contributors by increasing disease susceptibility, although only limited evidence was available to evaluate these candidate causes. The CADDIS process was particularly beneficial for optimizing further data collection and analysis efforts. The financial and personnel resources of the state were redirected to the priorities identified by assessment: endocrine disruptors, parasites and pathogens.

RHODE ISLAND

Partners: Rhode Island Department of Environmental Management (RI DEM), Rhode Island Department of Health, City of Newport

Challenge: Establish target phosphorous and chlorophyll-*a* concentrations necessary to restore and protect the Newport Water Supply Reservoirs (completed)

Resource: Analysis of nutrients and other parameters in water



“EPA ORD’s contributions to the effort – spanning from its inception to its end – were critical to its success. Of utmost significance was the ORD Atlantic Ecology Division’s involvement in securing analytical chemistry support from ORD’s Mid-Continent Ecology Division in Duluth, MN, and in performing certain instrumented analyses critical in enabling RI DEM to pursue a comprehensive monitoring program to evaluate relationships between nutrients, algae and cyanobacteria production, total organic carbon and disinfection by-product formation that serve as the foundation for setting TMDL targets for these critical water supply reservoirs.” –

RI DEM Office of Water Resources Deputy Chief Elizabeth Scott

In 2014, RI DEM identified all nine Newport Water Supply Reservoirs as impaired, citing low water clarity, low levels of dissolved oxygen, frequent algal and cyanobacteria blooms, and elevated levels of total phosphorus, total organic carbon and chlorophyll-*a*. RI DEM added each of the reservoirs to the List of Impaired Waters under the Clean Water Act, and initiated a Total Maximum Daily Load study to address their degraded water quality. The goal of the study was to establish target phosphorus and chlorophyll-*a* concentrations that will ensure algal growth and total organic carbon concentrations are reduced to a level that supports safe drinking water and protects aquatic life as required under the Clean Water Act.

To assist RI DEM, EPA ORD collected water quality monitoring data biweekly from early May through mid-October 2015, from the nine impaired reservoirs located in Newport, Middletown, Portsmouth, Little Compton and Tiverton – all towns in southeastern Rhode Island. RI DEM, in consultation with the Rhode Island Department of Health, will use the analytical chemistry data results to help establish the target total phosphorous and chlorophyll-*a* concentrations necessary to restore and protect the Newport Water Supply Reservoirs.

SOUTH CAROLINA

Partners: South Carolina Department of Health and Environmental Control (SC DHEC), South Carolina Department of Commerce (Commerce), and the City of Columbia

Challenge: Food waste reduction and landfill diversion (ongoing)

Resource: Food Waste Tracker Technology in collaboration with the U.S. Army (Fort Jackson)



“EPA ORD’s proposal of the LeanPath demonstration came at an optimal time for Fort Jackson. In the installation’s efforts to meet Net Zero Waste initiatives, we have explored ways to divert solid waste from the landfill via off-site composting and food donations. With the implementation of the Lean Path scales, we are able to collect data that supports these measures. Additionally, there is the opportunity to critically assess our dining operations and identify ways to improve operations and make fiscally-sound decisions. EPA ORD has been very engaging and more than helpful during the demonstration.” – U.S. Army Garrison Fort Jackson DPW-Environmental Division, Senior Project Manager Tameria Warren

The U.S. Department of Agriculture estimates that one out of six people struggle with hunger in the United States, yet food waste is the single largest component being sent to landfills and accounted for 21 percent (35.2 million tons) of the nation’s waste in 2013. South Carolina alone produced an estimated 607,000 tons of food waste in 2015.

In 2014, researchers with EPA ORD’s Net Zero program initiated a partnership with SC DHEC, SC Commerce and the U.S. Army to better manage organic waste in the Columbia, SC region. ORD’s Net Zero partnerships work with communities and military installations to develop and apply innovative approaches to reduce energy, landfill waste and water use. Collaborators in this South Carolina partnership included representatives who work on waste management issues from local businesses, municipal officials, non-governmental organizations and the Fort Jackson Army base. The partnership provided opportunities to share ideas and best practices through conferences and face-to-face meetings. EPA also conducted a feasibility study for the partnership that recommended strategies for optimizing recycling, repurposing and recovery of organic materials in the region. Since the partnership was created, South Carolina has launched several educational and food waste diversion campaigns, including the “Don’t Waste Food SC” state-wide campaign:

(www.scdhec.gov/HomeAndEnvironment/Recycling/FoodWaste/).

As a follow-on activity, in March 2017, EPA provided technical expertise, community outreach and funding to conduct a technology demonstration study using the *Lean Path 360* food waste prevention technology at the Fort Jackson Army base – one of the largest military training installations in the nation. LeanPath is an automated food waste tracking system that helps companies and organizations reduce food waste (www.leanpath.com). The project is ongoing, but to date, it has resulted in over 4,000 pounds of food being donated to South Carolina food donation and composting programs.

TEXAS

Partner: Texas Commission on Environmental Quality (TCEQ), Texas Department of State Health Services (DSHS) and City of Corpus Christi

Challenge: Chemical contamination in Corpus Christi's water supply (completed)

Resources: Determine health risks and action level

"The water situation in Corpus Christi last December was a good example of cooperation between Texas and EPA and the success we have when all work towards solving an environmental issue." – TCEQ Chairman Bryan W. Shaw, PhD, PE



In December 2016, EPA ORD scientists, in coordination with Region 6 (South Central U.S.), responded to a request for assistance in Texas after an asphalt emulsifying agent, Indulin AA-86, contaminated Corpus Christi's water supply. Toxicity information along with treatment options to remove this chemical from water was lacking. ORD researchers provided assistance early in the response concerning decontamination approaches that might be suitable for use in removing the contaminant from the system. In addition, EPA helped dissect and understand the toxicity of the chemical and possible risks associated with ingestion of contaminated water and the water soluble salt

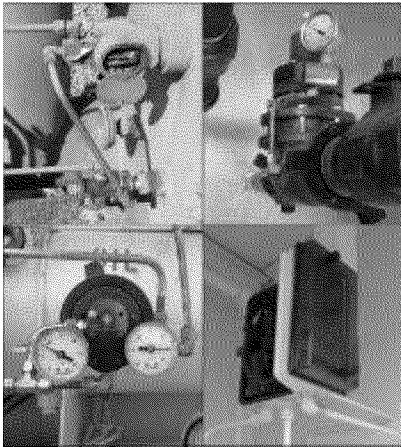
from the product. Texas state agencies, TCEQ and the Texas DSHS, along with ORD researchers worked together to establish a health-based action level for the contaminant and supported an immediate need to protect public health.

UTAH

Partners: Utah Department of Environmental Quality (DEQ), Oil and Gas Cooperators

Challenge: Support efficient development of U.S. energy resources while protecting human health (ongoing)

Resource: Next generation measurement methods



“EPA ORD has been a valuable partner in our efforts to advance needed energy development while improving air quality in the Uinta Basin.” – Utah DEQ Executive Director Alan Matheson

Oil and natural gas production has increased significantly within Utah’s Uinta Basin and across the United States over the last decade. Approximately three-quarters of the production in the Uinta Basin is on Indian Country within the Uintah and Ouray Reservation. Oil and natural gas extraction and production activities co-emit volatile organic compounds, a subset of which consists of air pollutants that are hazardous to human health, and greenhouse gases directly to the atmosphere.

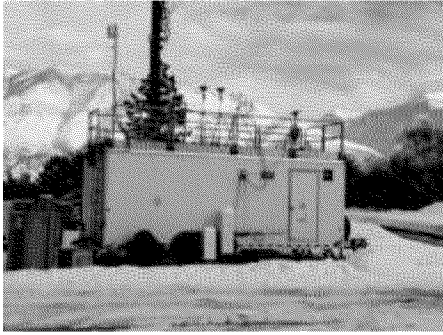
EPA ORD researchers in collaboration with Region 8 (Mountains and Plains) are working with state officials and oil and gas operators to conduct emissions research on pneumatic controllers used in upstream production for improved process control and safety functions. Because of the very large number of these devices, they contribute significantly to air emissions, however some uncertainty remains regarding the real-world emissions from these devices. In 2016, research was conducted in cooperation with oil and gas operators in the Uinta Basin, Utah on assessing emissions from pneumatic controllers (<http://www.scirp.org/Journal/PaperInformation.aspx?PaperID=75669>).

The ongoing collaboration between EPA, the state of Utah, and oil and gas operators will improve understanding of these devices and measurement methods, and ultimately support better development of U.S. energy assets in ways that also protect human health and the environment.

Partner: Utah Department of Environmental Quality (DEQ)

Challenge: Fine particle air pollution (ongoing)

Resource: Ground-based and remote sensing air measurements for the Utah Winter Fine Particulate Study in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and other partners



"The in-kind funding EPA provided, including the sophisticated instrumentation, lab analysis and project management support, was invaluable in making [the 2017 Utah Winter Fine Particulate Study] a success. The nature of fine particle pollution during northern Utah's periodic winter inversions presents a complex scientific problem [which Utah] has been analyzing for many years, and the insight and technical expertise of EPA researchers will certainly help in our efforts to tackle this difficult problem. We are hopeful the measurements and analysis of the complex atmospheric chemical reactions this study captured will enhance our ability to create effective policy tools to improve Utah's air quality during these winter episodes." – Utah DEQ Executive Director Alan Matheson

during these winter episodes." – Utah DEQ Executive Director Alan Matheson

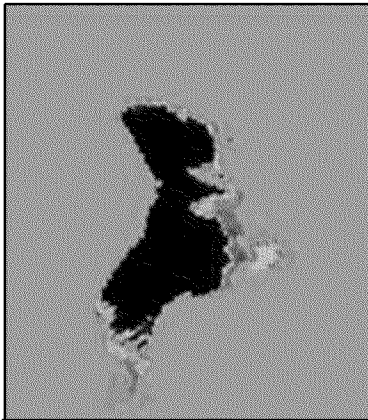
During the winter in Utah's northern valleys, cold air inversions trap pollution emitted from vehicles, industry and agriculture. This allows atmospheric chemicals to mix and leads to the formation of fine particulate matter (PM_{2.5}), which is an air pollutant that is harmful to health when it is concentrated at high levels.

In 2017, EPA ORD is providing support to the Utah in its Utah Winter Fine Particulate Study – one of the most comprehensive efforts to date to determine the chemical processes in the atmosphere that lead to the formation of PM_{2.5}. During January and February, ORD scientists collected ground-based air measurements using new techniques they developed in the lab and remote sensing technology. The data are being combined with measurements of the upper atmosphere. NOAA is taking these measurements using aircraft to obtain a complete analysis of atmospheric chemistry in the valleys. The data from the study will be used by Utah DEQ to develop effective strategies for their State Implementation Plan to reduce PM_{2.5} levels during the winter months. The study will help to improve air quality for the more than two million residents who live in the area.

Partners: Utah Department of Environmental Quality (DEQ)

Challenge: Satellite-derived cyanobacteria detection in support of public health protection in Utah (ongoing)

Resource: Cyanobacteria Assessment Network (CyAN) in collaboration with the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS)



Sentinel-3 Image (above)
Photo credit: European Space Agency, processed by NOAA

“The images we've been receiving through the CyAN project have been tremendously helpful to the Utah Division of Water Quality (UDWQ), providing the foundation for a wide range of useful outputs. It allows UDWQ to better target field sampling and more efficiently use our limited resources to protect public health. Finally, images are easily shared with response agencies as a useful visual communication aid.” – UDWQ Biological Assessment and Harmful Algal Bloom Programs Coordinator Benjamin M. Holcomb

Harmful algal blooms (HABs) occur when ideal conditions spark the uncontrolled growth of colonies of toxin-containing cyanobacteria—simple, aquatic organisms more commonly known as blue-green algae. Such blooms can make water unsafe for people, pets and wildlife. To better protect them, EPA ORD, in partnership with NASA, NOAA, and the USGS, are developing the [Cyanobacteria Assessment Network's](#) (CyAN) early warning system. The system uses historical and current satellite data to detect algal blooms in U.S. freshwater systems.

Based on the severity of cyanobacteria blooms in 2016, EPA ORD, in collaboration with Region 8 (Mountains and Plains), provided technical assistance to the state of Utah to use CyAN to monitor freshwater resources across the state. Utah DEQ issued an advisory about a cyanobacteria bloom, warning the public to keep themselves and their pets safe by staying out of Provo Bay. Local news articles related to the Utah DEQ press release also acknowledge the bloom was first detected via satellite imagery.

The CyAN project focused on selected states, including California, Connecticut, Florida, Massachusetts, New Hampshire, Ohio, Rhode Island and Vermont in 2016-17. It has already begun to expand to continental U.S. coverage in 2017 using the MEdium Resolution Imaging Spectrometer (MERIS) archive from 2002-2012. Weekly composites of the European Space Agency ([ESA](#)) [Sentinel-3 Ocean and Land Colour Instrument \(OLCI\)](#) sensor data will soon be made available to collaborators for initial review and validation when the data becomes publicly available by ESA. Researchers aim to continue to expand CyAN's capabilities to report state-level concentrations and extent of cyanobacteria.

VERMONT

Partner: Vermont Department of Environmental Conservation (DEC)

Challenge: Prioritization of developed areas for retrofit stormwater best management practices (completed)

Resource: High resolution impervious cover data for Vermont watersheds

"The impervious cover data we received from EPA saved me one to two days of work in our efforts to bring increased awareness of the negative impacts on water quality of impervious surfaces which are directly connected to surface waters in developed areas. Increased awareness of problem areas helps us work with municipalities to mitigate impacts." – Vermont DEC Watershed Management Division, Hank (David) Ainley



EPA ORD has developed methods for high accuracy classification of high resolution (1-meter) imagery for impervious cover from the U.S. Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) imagery for impervious cover with the understanding that such data are needed by states and local communities for infrastructure and development planning. Vermont DEC was looking for mapping data to quickly prioritize developed areas for stormwater best management practices retrofits. ORD was able to provide copies of the in-house developed high resolution impervious cover data, developed in-house, to Vermont DEC's Watershed Management Division.

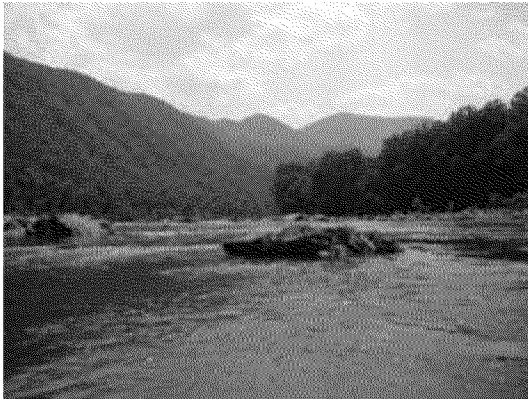
Vermont DEC staff are now using these data in conjunction with mapped sewer drainages to quantify connected impervious cover in municipalities with wastewater treatment plants. Vermont DEC is also comparing the condition of streams in watersheds with differing levels of connectivity and using this information to inform decision on where to retrofit. Together Vermont and EPA are exploring ways in which ongoing ORD research on watershed-scale effects of nature-mimicking infrastructure development can complement the state's efforts.

VIRGINIA

Partners: Virginia Department of Environmental Quality (DEQ)

Challenge: Integration of state and national stream condition assessments (completed)

Resource: Probabilistic survey designs integrating national and state reporting requirements



“Virginia DEQ has found it very helpful to integrate our state stream condition assessment into the National Streams and Rivers Assessment. With technical assistance from ORD, we were able to apply robust statistical analysis to calculate a picture of stream health for the entire state from a small, manageable set of field samples.” – Virginia DEQ Director David Paylor

Virginia DEQ is charged with reporting stream condition for the state, presenting a challenge to strategically conduct sampling protocols that will accurately represent stream water quality across the state’s many streams without overwhelming state resources. EPA researchers have pioneered the design of just such

survey techniques to assist water quality analysis across large areas. The EPA-developed strategy of probabilistic surveying has been incorporated into the National Aquatic Resources Surveys (NARS), which includes national-scale assessments of rivers and streams, lakes, coastal zones and wetlands.

Virginia DEQ took steps to integrate the state stream condition assessment requirements with the NARS National Rivers and Streams Assessment (NRSA). To achieve this, Virginia DEQ collaborated with EPA ORD to develop and interpret probabilistic survey designs specifically for their state stream condition assessments. The resulting survey design ensures representativeness of sampling locations, which then facilitates the use of statistical tools to determine condition values that incorporate acceptable levels of uncertainty. Virginia also adopted NRSA stream condition field and laboratory procedures to further integrate with the NRSA approach. Because of common measurements and survey design, Virginia will use the stream sites from their state program for the NRSA 2018-19 monitoring, thus promoting inter-calibration and efficiency.

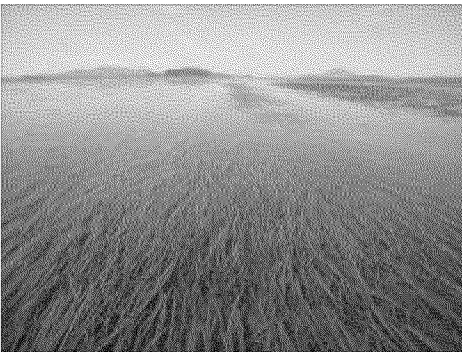
WASHINGTON

Partner: Washington Department of Natural Resources (DNR)

Challenge: Selecting sites for restoration of native seagrass beds and managing invasive species (ongoing)

Resource: Habitat suitability models for native and invasive seagrasses in collaboration with the U.S. Army Corps of Engineers

“The eelgrass biomass production model, developed by EPA ORD’s Newport lab, is a critical module in the eelgrass site selection model. A multi-faceted team of state, federal and private sector scientists integrated an existing Puget Sound coupled physical and biogeochemical model with the eelgrass biomass production model to identify sites where the biomass of transplanted eelgrass would increase over time. Knowledge of these parameters vastly improve eelgrass restoration site selection and transplant success.” – Washington DNR, Aquatic Biologist Dr. Jeffrey Gaeckle



Seagrass meadows are valued by coastal communities and tribes as nursery habitats for fisheries species (such as Dungeness crabs, bay clams, Chinook and Coho salmon) and habitat for multitudes of forage species that support fisheries and wildlife in the Pacific bays and estuaries. Washington has a goal to increase the area of native seagrass beds in the Puget Sound by 20 percent by the year 2020. This requires knowledge of where restoration and habitat conservation efforts will be most successful. Washington DNR, working with Pacific Northwest National Laboratory as part of the Puget Sound Partnership, has been using EPA ORD research on seagrass physiology to help identify

locations where native seagrass (*Zostera marina*) are likely to thrive. These sites were then prioritized for further assessment and the potential for seagrass restoration. Sites with favorable environmental conditions based on model output are more likely to be successfully restored with eelgrass.

In Washington, Japanese eelgrass has been identified by the shellfish aquaculture industry as a noxious weed that disrupts the growth and harvest of Manila clams. ORD has also been conducting research on the ecology of Japanese eelgrass and developed a habitat suitability model to determine where this invasive species has the potential to become established. Knowing where the invasive seagrass is likely to colonize can assist aquaculture biologists in developing efficient surveillance and eradication plans.

Partner: Washington Department of Fish and Wildlife (DFW)

Challenge: Managing nutrients in riparian ecosystems for fish and wildlife benefits (ongoing)

Resource: Science synthesis of nutrient processes in riparian ecosystems



“EPA’s willingness to co-author the nutrient chapter of the Washington DFW’s riparian science synthesis document was critical to providing the best science to biologists, managers and policy makers throughout Washington. We viewed EPA as an essential partner that provided a very high level of expertise that Washington DFW simply did not have.” – Washington DFW, Chief Scientist Dr. Timothy Quinn

Riparian ecosystems and their streams are critically important locations for sustaining a healthy balance of nutrients –primarily carbon (C), nitrogen (N), and phosphorus (P) – across watersheds and far downstream. Vegetated riparian areas can be efficient natural

filters by storing, removing and “fixing” potentially harmful excess nutrients that flow into aquatic ecosystems from uplands dominated by human activities, such as agriculture and urbanization.

To assist Washington DFW, EPA ORD scientists provided state-of-the-science information on nutrients and riparian ecosystems as a chapter in an upcoming guidance manual designed for states, tribes and commercial interests responsible for managing riparian zones. The chapter provides a basic understanding of nutrient (C, N and P) cycling in riparian zones, including stream channels and Pacific Northwest groundwater. In highlighting the well-studied effects of various land uses, this chapter provides for state officials the key factors they need to consider for maintaining conditions needed for optimal nutrient transport, such as hydrologic connection, vegetation type, soil condition and salmon use of streams.

Partners: Washington State Department of Ecology

Challenge Upper Columbia River contaminated site (ongoing)

Resource: Technical support for remedial investigation/feasibility study



“Washington is addressing surface soil legacy smelter-emission impacts across a range of communities and settings spanning the state. The assessment of state-of-the-art, minimally disruptive exposure reduction surface treatment technologies for rural-residential and rural tribal-use settings common to the upper Columbia River Valley is a fundamental step toward identifying long-term cleanup measures. ORD’s participation is highly valued to ensure honest assessment, input and multi-disciplinary scientific oversight.” — Washington State Department of Ecology, Toxics

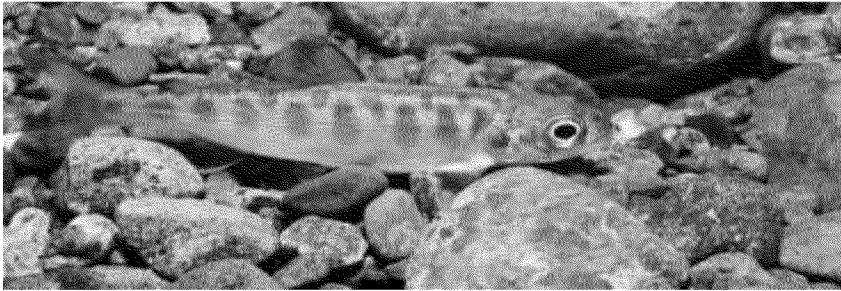
Cleanup Program, Upper Columbia River Site Project Coordinator John Roland

EPA ORD, in coordination with Region 10 (Pacific Northwest), is providing technical support for the Upper Columbia River (UCR) Valley Superfund Site’s remedial investigation/feasibility study. EPA ORD is a member of the UCR Soil Amendment Technologies Evaluation Study technical team established through the interaction of the Coleville Confederated Tribes, Washington State Department of Ecology, Teck Resources Limited, Ramboll Environ and EPA Region 10. EPA ORD is engaged as a third-party to provide an unbiased, scientific assessment of, and expertise on, soil amendment alternatives for soil lead and associated metals in the UCR area. Amendment alternatives being evaluated include phosphate, magnesium oxides, ECOBOND®, compost, biochar and other widely accepted treatment options for lead in soil. At this point, EPA has provided input on potential alternative treatments for the site, and provided input on testing that could be done to predict treatment suitability/effectiveness at the site. EPA ORD also participates in site meetings and teleconferences with the region, state and potentially responsible party to discuss the site soils and alternative soil remediation approaches.

Partners: Washington State Department of Ecology, Nooksack Indian Tribe, Lummi Nation

Challenge: Anticipating stream temperature stress on cold water fishes (salmon) in the Northwest (ongoing)

Resource: Long-term outlook models for rising stream temperatures to determine potential impacts of elevated temperatures and to examine potential mitigation strategies, in collaboration with the University of Washington, the U.S. Forest Service, NOAA Fisheries and U.S. Geological Survey



*...ed temperature and habitat degradation
...ior threat to the many types of fish that
...s watershed. Through the process of
...and data collection, we learned we must
...thing we can to keep water quality
...s stable over the next few decades. We
...uld have had the ability to look into the
...thout the help of ORD.” – Washington*

State Department of Ecology, Water Quality Engineer Steven Hood

Stream temperatures in the Pacific Northwest are projected to increase under future long-term weather scenarios due in part to increases in air temperature and in part to changes in water levels and water flow caused by altered rain and snowmelt patterns. Combined, these changes in stream temperature and hydrology could have substantial negative effects on cold-water fish species such as salmon. To better understand the potential impact of long-term weather changes on the potential to achieve water quality and salmon recovery goals, EPA ORD, in collaboration with Region 10 (Pacific Northwest) and the Office of Water, launched a collaborative research project in the South Fork Nooksack River with the Washington State Department of Ecology.

The research plan incorporates the total maximum daily load (TMDL) for temperature, which was developed by the Washington State Department of Ecology for the South Fork Nooksack River, as a pilot for integrating future weather scenarios into a watershed-specific plan to improve water quality for cold-water fish species. An overarching goal is to ensure that relevant findings and methodologies related to future stream temperature scenarios inform the South Fork Nooksack River Temperature TMDL Implementation Plan under development by EPA Region 10 and the state of Washington.

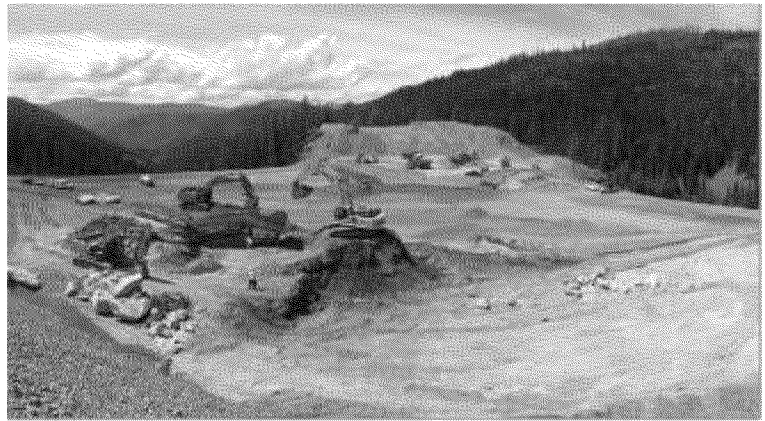
Partners: Washington State Department of Ecology

Challenge: Bunker Hill Superfund Site (ongoing)

Resource: Technical support

"The Washington State Department of Ecology appreciates ORD's involvement in the Bunker Hill Superfund Site. The tools being developed by ORD will not only ensure that lakes and marshes receive appropriate cleanups and reduce contaminant transport into Washington, but also may assist us in determining the best remedial strategies at our own cleanup sites." – Washington State Department of Ecology, Toxics Cleanup Program Hydrogeologist Sandra Treccani

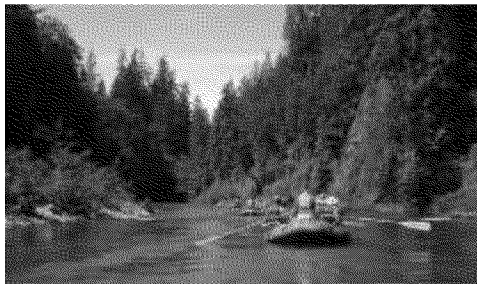
The Bunker Hill Superfund Site, often referred to as the Coeur d'Alene River Basin Cleanup Site, is located in northern Idaho and eastern Washington where early mining and milling methods led to environmental contamination from mine wastes. EPA ORD is providing technical support for a portion of the site including the lakes, wetlands, flood plains and Coeur D'Alene river west of Bunker Hill. EPA ORD scientists continue to assist with document reviews for capping proposals, as well as other remedial design input for this mega-site. This site will be studied by EPA ORD soil scientists to identify remedial alternatives for Coeur d'Alene side lakes and marshes utilizing a historically heavily used marsh, Lane Marsh, for migratory birds. Successful pilot studies developed at Lane Marsh will be eventually be tested at other locations within this portion of the site.



Partners: Washington Department of Natural Resources, Washington Department of Ecology, Nisqually Land Trust, Nisqually Tribe

Challenge: Improve watershed condition for salmon recovery, clean drinking water and other ecosystem services (ongoing)

Resource: EPA watershed restoration planning tools (VELMA, Penumbra) and technical support



“Guided by sophisticated new modeling from EPA ORD’s Western Ecology Division in Corvallis, combined with modeling used by the Nisqually Tribe for salmon recovery, the community forest’s management team will selectively thin the property’s timber stands to encourage old-growth forest characteristics and increase stream flow during the fall spawning season.” – Nisqually Land Trust Executive Director Joe Kane

Intensive forest management in the Pacific Northwest during the past century has emphasized clearcutting on short harvest intervals (40-50 years). This highly profitable practice has converted the region’s vast pre-settlement old-growth forests to young forest landscapes. This has fundamentally changed the functioning forest watersheds and their capacity to sustainably provide essential ecosystem services (nature’s benefits) for local and downstream communities. Provisioning of drinking water, flood protection, fish and wildlife habitat, and recreational and cultural opportunities have been significantly degraded in many places.

Indicative of these widespread changes, Puget Sound salmon populations have declined sharply from historic levels. For example, 22 of at least 37 Chinook populations are now extinct, and many other species are listed as endangered. Communities, tribes and state agencies (Departments of Natural Resources and Ecology) are now collaborating throughout the region to implement salmon recovery plans that aim to restore hydrological and ecological processes critical to salmon recovery, and more broadly, to the functioning of entire watersheds and the ecosystem services they provide. A prime example is the Nisqually Community Forest (NCF), a novel collaboration of communities in southern Puget Sound (<http://nisquallylandtrust.org/our-lands-and-projects/nisqually-community-forest/>) aimed at acquiring private forest industry lands from willing sellers. The NCF is a working forest owned and managed for the benefit of local communities.

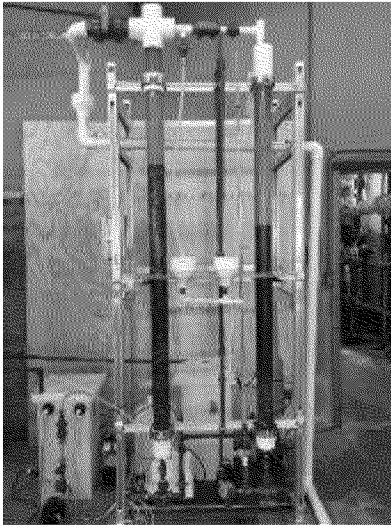
EPA ORD has developed and transferred modeling tools to NCF to support their salmon-recovery planning in the Mashel River watershed, a once prime salmon producing sub-basin of the Nisqually River. NCF staff are currently using EPA’s Visualizing Ecosystem Land Management Assessments (VELMA) watershed simulator to quantify long-term effects of alternative management and climate scenarios on key salmon habitat and water quality variables. A key NCF goal is to design sustainable management plans that emphasize forest thinning and robust riparian buffers, a strategy shown by VELMA simulations to restore greater summer stream flows favorable to salmon spawning. Other ongoing NCF projects using VELMA include prioritization of land acquisitions, community-based best management practices and long-term management strategies.

MULTI-STATE STORIES

Partners: Illinois, Indiana, Iowa and Ohio

Challenge: Cost-effective removal of ammonia from drinking water (completed)

Resource: New cost-effective treatment technologies for small drinking water systems



"Given the array of challenges faced by small drinking water systems, ORD's development of an affordable and easy to use ammonia treatment technology is very helpful to Iowa and many other states. Technical and research support of small drinking water systems is very important to Iowa." – Iowa DNR Environmental Services Division Director Bill Ehm

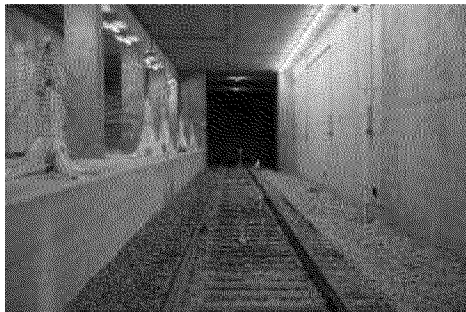
EPA ORD has developed new, affordable and easy-to-use biological drinking water treatment systems to implement in small drinking water systems. Ammonia is found at high levels in many agricultural areas where groundwater is the primary drinking water source. And while ammonia itself is not a regulated contaminant, it can be a significant source for nitrate—a regulated contaminant—within the pipes of drinking water distribution systems. When nitrate exceeds regulated levels, it poses significant health risks to infants with symptoms that include shortness of breath and blue baby syndrome.

The biological treatment technologies developed by EPA ORD engineers have been tested at the pilot scale in Ohio, Illinois, Indiana and Iowa. The systems were tested under a number of challenging conditions for their ability to remove ammonia, as well as elevated iron, manganese and arsenic levels. The new treatment technology, recently patented by EPA ORD and licensed to a private company, provides a solution to small drinking water systems in areas with high groundwater ammonia levels.

Partners: California, District of Columbia, Massachusetts, New York and Virginia

Challenge: Cleanup of an anthrax contaminated subway (ongoing)

Resources: Full scale demonstration of technologies



"The work being done with the Underground Transportation Restoration Operational Technology Demonstration project has been critically important to helping Washington Metropolitan Area Transit Authority and other mass transit properties face the daunting preparedness challenges associated with an accidental or intentional release of a biological agent in the underground transportation environment. The project has helped inform our leadership in determining operational strategies that will lead to a more rapid return to service following such an event." – Homeland Security Investigations and Intelligence Bureau

Metro Transit Police Department, CBRN Coordinator Brandon W. Graham

Following the 2001 anthrax attacks, cleanup of the Hart Senate Office Building and Brentwood postal facility cost in excess of \$1 billion, and resulted in the Brentwood postal facility being closed for over two years. Since that time, EPA ORD has done a great deal of work to improve the nation's ability to cleanup buildings contaminated with anthrax or other biological agents. In recognition of the complexities that would be involved, and the number of cities that have underground rail systems, EPA along with the Department of Homeland Security, the Department of Defense and several national laboratories turned their attention to the cleanup of subway systems that could be contaminated with anthrax.

The Underground Transportation Restoration (UTR) Operational Technology Demonstration (OTD) was conducted during September 2016 at Fort A.P. Hill's Asymmetric Warfare Training Center to evaluate decontamination technologies that could be used in the event of an anthrax incident in a subway system. The project used a non-pathogenic surrogate that behaves much like anthrax spores in terms of how it is transported in the air, settles and how it can be killed.

The project consisted of two rounds of background sampling, agent release, decontamination, sampling, waste removal and decontamination, and post-decontamination sampling. The technologies that were evaluated included a fogger that produced a fog from diluted bleach and a skid mounted sprayer that sprayed a liquid pH adjusted bleach solution. Both technologies were selected because they are off-the-shelf and could easily be purchased in an emergency.

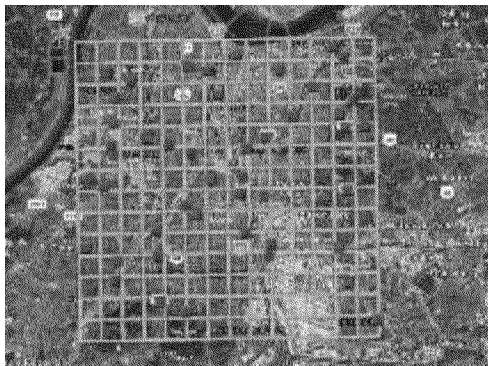
Thousands of post decontamination samples were collected and are currently being analyzed, and a report is expected to be published in 2018. The success of the decontamination efforts will not be known until the samples are processed and results available and studied, but the demonstration was helpful in defining the many challenges that could be faced during a real incident including sealing portions of a subway tunnel, sampling unique surfaces such as railway ballast, and managing wastes that cannot be decontaminated in situ.

Watch the [Underground Transportation Restoration Project](#) video to learn more.

Partners: Florida Department of Environmental Protection, Georgia Environmental Protection Division, Kentucky Department of Environmental Protection, North Carolina Department of Environmental Quality, South Carolina Department of Health and Environmental Control and Tennessee Department of Environment and Conservation

Challenge: Characterizing urban background levels for contaminated site cleanup levels (ongoing)

Resource: Sampling protocol



“Having a data set like the one gathered during the urban background study is invaluable. It is very helpful to now have a comprehensive data set that we can use to make scientific determinations regarding appropriate urban background concentrations for many constituents.”—Tennessee Department of Environment and Conservation Environmental Consultant Merrie Embry, in the Memphis Environmental Field Office, who also noted that the benefit of working with EPA ORD and the other Southeastern states has helped to ensure consistency in their sampling approach and data evaluation.

In 2015, EPA scientists partnered with several Region 4 (Southeast) states to figure out how urban background contaminants differ from industrial waste at urban sites. Initial efforts were focused on creating a process for both soil sample collection and analysis that could be consistently applied across southeastern cities.

Soil samples collected from Louisville, KY; Lexington, KY; Memphis, TN; Raleigh, NC; and Winston-Salem, NC, were analyzed in EPA laboratories and added to a growing urban background database for metals and PAHs. The data and sampling process can be used by EPA, state agencies and local authorities to assess hazardous waste and brownfield sites and make decisions around cleanup. The database will provide a general range of urban background contaminant levels to be expected from sites in Region 4 cities. It can also serve as a screening tool for comparison of potential sites. The utility of the tool is improved as coverage of data for comparison over broader areas increases and more urban background data are added.

The success of the project has allowed sampling efforts to expand to additional cities in Tennessee, Georgia and Florida. Recently, EPA and the state of Tennessee have used the study protocol to conduct an urban background sampling effort in Chattanooga, TN. Additional regions, states and universities, including Georgia State University in Atlanta, have expressed interest in the results and established sampling process. Professors and students at the University of Florida in Gainesville have already used the sampling process in two urban areas in central Florida.

Partners: Participating pilot locations including the cities of Chicago, IL; Durham, NC; Hartford, CT; Houston, TX; Kansas City, KS; Oklahoma City, OK; Philadelphia, PA and Washington, DC

Challenge: Air quality monitoring for community awareness (ongoing)

Resource: Village Green Project



“The Village Green station is a helpful tool in educating the public, and particularly children, about the importance of air quality in our everyday lives. We are thankful to be one of several cities across the country to have such an innovative tool.” – Oklahoma DEQ Executive Director Scott Thompson (referring to the Village Green Project in Oklahoma City)

The Village Green Project (VGP) is a novel air and weather measurement station originally developed by EPA ORD scientists. The station is a compact, solar-powered system that incorporates air and weather instrumentation into a park bench. The project builds upon the need to enhance transparency and showcases

next-generation air measurement technology by providing quality-assured data to the public on a near real-time basis, updating to a public data website every minute.

The original prototype was field-tested outside a public library in Durham, NC. Following the successful prototype test, EPA created a pilot VGP expansion and engaged with state, local and tribal agencies in placing new park bench stations in various community environments. There are currently eight Village Green stations in the U.S. located in a variety of environments selected by the grant recipients, such as libraries, a public garden, and high foot-traffic tourist areas. In addition to Oklahoma City, OK and Durham, NC, participating cities include Hartford, CT, Kansas City, KS, Houston, TX, Washington, DC, Chicago, IL, and most recently Houston, TX. The state and local agencies have used the stations as an opportunity to host public outreach events, including ribbon-cutting ceremonies and informational sessions.

Partner: Wisconsin Department of Natural Resources (DNR), Lake Michigan Air Directors Consortium (LADCO)

Challenge: Better understanding of Lake Michigan's ozone formation and transport (ongoing)

Resource: Reference methods, optical and remote sensing analyses and federal research vessel in collaboration with the National Oceanic and Atmospheric Administration (NOAA), NASA, the University of Iowa, the University of Northern Iowa, the University of Minnesota, the University of Wisconsin via the National Science Foundation, and the Electric Power Research Institute (EPRI)



"This study will improve the models that we use to inform science-based decision making." — Wisconsin DNR, Environmental Management Division Pat Stevens

Ozone is formed when compounds such as nitrogen

oxides (NO_x) and volatile organic compounds (VOCs) react with sunlight. Despite dramatic reductions in these ozone precursor emissions, many areas bordering Lake Michigan continue to experience elevated ozone concentrations. This long-standing issue is one of the more challenging air quality issues in the eastern U.S.

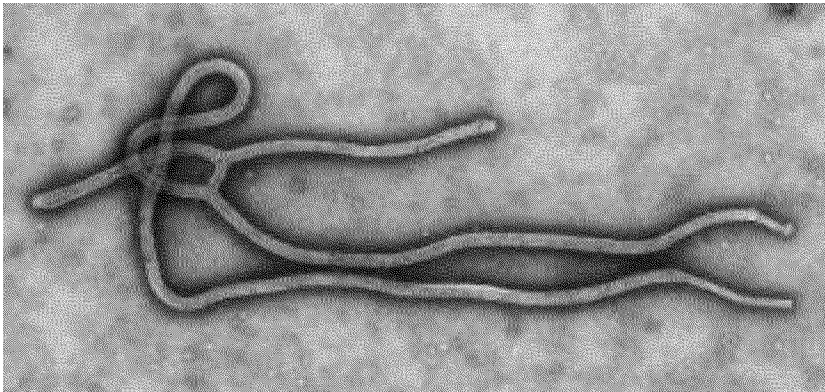
A problem that is hindering states and stakeholders addressing this challenge is that Lake Michigan's unique meteorology and ozone chemistry, including the transport of ozone and ozone precursors in the region, are not completely understood. Photochemical models are important tools for understanding such transport issues. However, these models historically have been unable to reproduce the lake breeze effect present around Lake Michigan, making it difficult for states, the LADCO and EPA to accurately predict and address ozone concentrations along the Lake Michigan lakeshore. LADCO is a regional planning organization that includes representation from Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin (<http://www.ladco.org/about/index.php>).

In the summer of 2017, EPA ORD, LADCO, academic institutions, and other state and federal agencies pooled their expertise and resources to commence a field study to collect information that will be used to better inform air quality models and ultimately help understand ozone formation around Lake Michigan. EPA ORD, in conjunction with NOAA and NASA, outfitted a NOAA research vessel with EPA instruments to support over-the-water measurements. NASA and EPRI are providing airborne remote sensing measurement to complement EPA and state surface measurements to help understand pollutant transport over Lake Michigan. These measurements will be combined with satellite data to better understand ozone chemistry and transport over the area, and better inform efforts to reduce ozone formation along the shoreline.

Partners: Maryland Department of Health and Mental Hygiene (DHMH), New York State Department of Environmental Conservation (NYSDEC)

Challenge: How best to decontaminate materials and manage waste and wastewater contaminated with the Ebola virus (completed)

Resources: Technical assistance



“During the 2001 and 2006 anthrax incidents in New York City and the 2014 Ebola crises, New York state reached out to EPA ORD and Region 2 staff for their experience and acumen to collaborate on creating a ‘complete waste solution.’ This involved designing training sessions, developing a computerized decision support tool (I-WASTE), a NYC Environmental Response and Remediation Plan for Biological

Incidents, and conducting and publishing research on the ability of commercial autoclaves to treat thermally resistant anthrax spores and the triple packaging used for transport of highly infectious agents. EPA ORD and Region 2 staff have been responsive to all of our state’s requests for assistance. Collaborative efforts by EPA and the NYSDEC have contributed significantly in the management of biohazardous waste that has been both timely and crucial to protecting public health and the environment in New York State and nationally.”— NYSDEC Division of Materials Management Research Scientist Alan Woodard, PhD

In 2014, there was an outbreak of Ebola cases in the United States. EPA ORD researchers were called upon to provide technical support to states in responding to the emergency. EPA ORD scientists provided technical support related to decontamination products and best ways to use them. They also delivered expert recommendations for best decontamination methods for personal protective equipment, a critically important issue for health care workers and others who came into contact with Ebola patients. EPA ORD provided instruction on how waste contaminated with the Ebola virus should be managed and the fate of the virus in wastewater. In addition, EPA ORD participated in a workshop with the Maryland DHMH and contributed to the National Security Council’s development of the *Multi-Agency Interim Guidance on Management of Wastes containing Category A Infectious Agents*, such as Ebola. With EPA ORD technical support and assistance, Maryland and New York were in a better position to address the challenges associated with managing waste from the Ebola crisis.

Partners: Alliance for Chesapeake Bay, Chesapeake Bay Foundation, Dauphin County Conservation District, Lancaster County Clean Water Consortium, Lancaster County Conservancy, Lebanon County Conservation District, Pennsylvania State University and Susquehanna River Basin Commission

Challenge: Managing stormwater treatment systems to protect and to restore water quality in the Chesapeake Bay (ongoing)

Resource: Center for Green Infrastructure and Stormwater Management



"An ounce of stormwater pollution prevention is worth a pound of cure, particularly when it adds multiple benefits through green infrastructure and natural treatment systems. The Center helps Chesapeake Bay states and stakeholders find solutions to some of our most challenging water quality problems through science-based innovation and collaboration." – Maryland Department of the Environment Secretary Ben Grumbles

The EPA ORD-supported Center for Green Infrastructure and Stormwater Management was established to conduct interdisciplinary research to understand and to influence how decisions are made at multiple spatial and jurisdictional scales to manage stormwater treatment systems that protect and restore water quality in the Chesapeake Bay. By the time indicators of impairment are measured within the Chesapeake Bay, the opportunity for adaptive management to alleviate the degradation of water quality may have already passed. It is therefore imperative to identify headwater landscapes that are particularly vulnerable to stress from high pollutant loads, population growth and changes in land management.

The Center serves as a focal point to bring together stakeholders and researchers from multiple disciplines to improve stormwater management in urban and suburban settings; to reduce pollutant loads of nutrients, sediments, organics and metals; and to minimize stormwater volume and energy use across a range of storm event magnitudes. To accomplish these objectives, the Center identified the cognitive and institutional barriers preventing communities from adopting green infrastructure measures to manage stormwater. Additionally, the Center designed green infrastructure and developed methods to help stakeholders visualize alternative infrastructures. It modeled the environmental and financial benefits of these alternative infrastructures and served as a forum for stakeholder discussions.

Partners: Maryland Department of Environment (MDE), California, Colorado, Connecticut, Kentucky, New Hampshire and Oregon

Challenge: Identifying appropriate opportunities to use advanced monitoring tools, new data collection and analysis techniques to create improvements and gain efficiencies in environmental monitoring (ongoing)

Resources: Development, pilot testing, and evaluation of advanced monitoring technologies

"Our partnership with EPA on advanced monitoring is extremely important. With new sensors entering the market every day, understanding if they work and how to communicate the data they generate is a critical need for state environmental agencies. In 2017, two major sensor studies are taking place in Baltimore, where hundreds of stationary and mobile sensors will be collecting data on multiple air pollutants and greenhouse gases. This partnership with EPA is both critical and timely." – MDE Secretary Ben Grumbles



Environmental monitoring is in the midst of a paradigm shift from data being collected, stored, distributed and communicated by the government to data being collected by anyone, anywhere and at any time. This shift is driven by recent technological advances, ubiquitous data communications and the reduced cost of monitoring technology.

EPA and the Maryland Department of Environment are co-leading a state-EPA effort to determine how to fully take advantage of rapid changes in environmental monitoring technology. New advanced monitoring technologies are already available that are smaller, more portable, and less expensive than traditional methods. However, the rapid evolution of monitoring technology also presents challenges to

government agencies, the public and the regulated community because the performance (i.e., accuracy, precision and reliability) of new technologies is largely uncharacterized. Communities, citizens, industry and local, state, federal and tribal agencies are asking the same question: "How good is it?"

In April 2016, the state-tribal-EPA collaborative E-Enterprise for the Environment Leadership Council recommended five actions for joint EPA-state work: 1) perform a detailed options and feasibility analysis on the creation of an independent third-party evaluation/certification for new technologies; 2) develop scanning and screening procedures within EPA and the states to help users make decisions on which equipment they should purchase or pilot; 3) develop messaging and tools to support the interpretation of monitoring results to ensure that data are properly interpreted and communicated to the public; 4) develop data standards for advanced monitoring technologies to facilitate distribution, sharing and integration of data; and 5) identify and implement efficiencies in current technology approval processes. EPA ORD is supporting these joint efforts, while continuing research on the use and performance of new monitoring technologies. For example, an EPA-supported research center will deploy a large, distributed network of low-cost air quality monitors in Baltimore and will collect data to assess variability in pollutant concentrations, source contributions and exposures across in the city.

Partners: Northeast States for Coordinated Air Use Management (NESCAUM), an association of eight Northeastern States including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont

Challenge: Northeastern states' planning for energy and air emissions (completed)

Resource: Energy system database



"EPA ORD, through its research programs, is well-positioned to support us in better understanding the numerous multi-state origins and inter-state transfer of air pollution and how it evolves as it travels to Rhode Island. No individual state in the Northeast is capable of studying this complicated issue alone." – Rhode Island Department of Environmental Management Director Janet Coit

The MARKet ALlocation (MARKAL) tool is used to model the nation's energy system and evaluate different energy technology options for reducing air quality emissions. The tool uses energy and water technology data to create future scenarios or options for optimizing water and energy consumption and management. City planners can run simulations on a variety of policy options to evaluate the most cost-effective and environmentally sustainable solutions for providing energy- and water-related services such as heating, cooling, and water and wastewater treatment.

EPA ORD has collaborated with NESCAUM in the further development of a MARKAL model tailored specifically to the energy infrastructure of the Northeast. This NE-MARKAL model was based on ORD's U.S.-scale 9 region MARKAL/TIMES optimization model database used by decision makers for coordinated energy and air emissions planning. ORD provided expertise and support for the development of state-level model database(s) and implementation of the modeling framework and case studies. The NE-MARKAL framework will be used by decision makers to examine energy policy options and their resultant impacts on energy services in the region.

Partners: Local and regional beach managers across states that border the Great Lakes, as well as other states

Challenge: Predicting water quality at beaches (completed)

Resource: Virtual Beach software



"This reliable, predictive water quality model is key to protecting health and promoting recreational enjoyment of our beaches. The model provides same-day public notifications of beach conditions at a lower cost than traditional monitoring. Communities that use Virtual Beach can dedicate more of their resources to locating and correcting sources of contamination and improving local beaches. The (Wisconsin DNR's) partnership with EPA in the development of this practical scientific tool offers a great pay off." – Wisconsin DNR Cathy Stepp (former secretary)

To protect public health, beach managers need to continually assess the level of potentially harmful microbes (primarily bacteria) in the water. However, traditional, culture-based testing methods take a full 24 hours to get results – preventing same-day, proactive beach closures and leaving many recreational swimmers open to sickness or infection. EPA's Virtual Beach tool offers a solution.

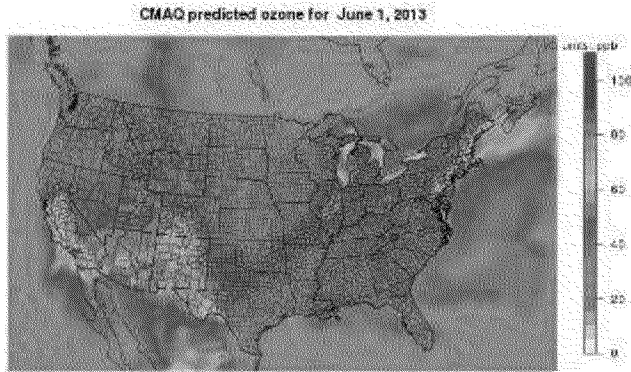
Virtual Beach (VB) is a Windows desktop-based software package designed by EPA researchers that provides rapid, real-time assessments of microbial water quality with model accuracy typically exceeding 80 percent. Beach managers use VB to develop site-specific statistical models for predicting fecal contamination based on readily-available data on such as wind direction/speed, rainfall and cloud cover as well as wave height, water turbidity and sunlight intensity. Once a model is developed for a site using historical data, environmental information can be collected at a site in the morning, and moments later the model can produce a prediction to guide decisions about closing the beach for the day or for issuing advisories.

VB is used to assist in advisory issuances in the Great Lakes states and to forecast water conditions in numerous locations in Wisconsin, Illinois, Indiana, Michigan, Minnesota, New York, Ohio and Pennsylvania. VB supports efforts to support the local economy while protecting the health of residents.

Partner: Maryland Department of Environment (MDE) and other state air agencies

Challenge: Need for effective strategies to reduce harmful air pollutants (ongoing)

Resource: EPA's Community Multiscale Air Quality (CMAQ) Modeling System



"Maryland has made dramatic progress over the past 10 years in reducing ozone and fine particle pollution. We have invested heavily into research and modeling and this investment has been one of the reasons we have been successful. The CMAQ photochemical model has been the key tool we have used to design and refine control strategies. It has helped us find least cost solutions to reduce ozone and fine particle pollution." – MDE Secretary Ben Grumbles

For more than 15 years, EPA and states have been using EPA's Community Multiscale Air Quality (CMAQ) Modeling System, a powerful computational tool for air quality management. CMAQ simultaneously models multiple air pollutants, including ozone, particulate matter and a variety of air toxics to help air quality managers determine the best air quality management scenarios for their states and communities.

State agencies that control air pollution use CMAQ to develop and assess implementation actions needed to attain National Ambient Air Quality Standards (NAAQS) mandated by the Clean Air Act. States use the tool to identify sources of air quality problems and to assist in the design of effective strategies to reduce harmful air pollutants. Using data about land use, meteorology and emissions, CMAQ provides detailed information about the concentrations of air pollutants in a given area for any specified emissions or air quality scenario. With information generated by CMAQ, states are able to examine the estimated impacts of different air quality policies.

The National Weather Service also uses the model to produce air quality forecasts twice daily, and the Centers for Disease Control and Prevention uses CMAQ data in two community-focused tools that allow users to access county-specific air quality information on pollutants, such as ozone and particulate matter.

CMAQ has a worldwide user community with users in 125 countries. The system brings together three kinds of models including: meteorological models to represent atmospheric and weather activities; emission models to represent man-made and naturally-occurring contributions to the atmosphere; and an air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions. The newest version of the model (CMAQ 5.2) is expected to be released in June 2017.

Partner: Interstate Technology and Regulatory Council (ITRC)

Challenge: Need for specialized risk assessment training (completed)

Resource: Training module, *Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment*



"The experience and knowledge of EPA scientists were essential to the success of this important training used by state risk assessors and others to address complex challenges at contaminated sites."

— California Department of Toxic Substances Control (State Co-Chair)
Claudio Sorrentino

"The ITRC risk training is more robust as a result of our partnership with EPA experts on this effort."—South Dakota Department of Environment and Natural Resources (State Co-Chair) John McVey

EPA ORD partnered with ITRC, a program of the Environmental Research Institute of the States, to develop specialized training for state risk assessors responsible for the cleanup of chemicals released into the environment. Based on feedback from EPA's Risk Assessment and Training Experience (RATE) program, ORD scientists reached out to ITRC and proposed that ITRC create training modules on the harmonization of risk assessment approaches across state regulators. EPA experts provided materials developed for its RATE program for the ITRC effort. These materials provide up-to-date and comprehensive training for human health risk assessment, ranging from beginner to expert classes.

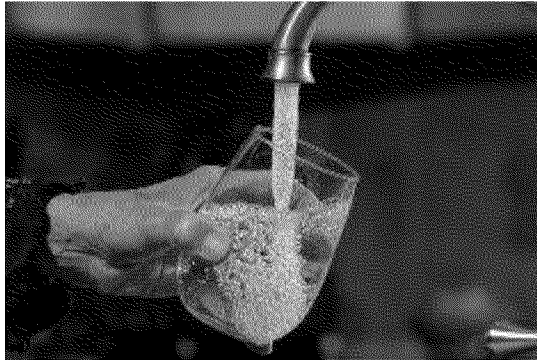
The ITRC team of approximately 75 representatives from various environmental sectors completed a comprehensive web-based training module entitled, *Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment*. ORD scientists provided expert technical support as needed along the development processes and extensive peer reviews before release of the final product. Currently, all interested risk assessors in the U.S. and around the globe have free access to this important training material (<http://www.itrcweb.org/risk-3/>). To date, more than 2,100 people have taken the online course and the associated guidance document is available to download.

Partner: Colorado, Florida, Kentucky, Michigan, New York and Ohio

Challenge: Simulating and monitoring conditions in drinking water utilities (ongoing)

Resources: Technical assistance and field support

"Having access to my operational data in real-time keeps me on top of the system performance even when I am not at the plant. This tool helps me manage my staff and resources by providing greater flexibility and real-time information." – Milford, OH Water Department Supervisor Matt Newman



EPANET-RTX (real-time extension) and RTX:LINK are software tools that have helped states and their drinking water utilities by allowing continuous monitoring of their operations to improve water quality and respond to incidents. Together states and their utility partners use the tools to better understand and help improve drinking water system operations.

EPANET-RTX was developed to allow utilities to link their raw Supervisory Control and Data Acquisition (SCADA) data with the EPANET distribution system hydraulic model to evaluate conditions in the system in real time. The development of real-time analytics can provide utilities with the necessary tools to enhance system operations including emergency response, improved pressure management, leak detection and water quality. EPANET-RTX is currently in use in many locations including Ohio, Colorado, Florida, Kentucky, Michigan and New York.

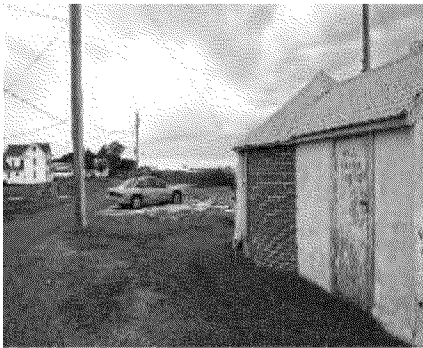
To make real-time monitoring available to small systems that lack powerful computing capability, RTX:LINK provides access to the SCADA data through mobile applications and desktop computers. RTX:LINK software provides simple and secure access to key water utility operational data streams, using web-based dashboards for trending and alerting. With RTX:LINK drinking water utilities have the ability to better understand water quality and operational conditions in their system at any point in time.

RTX:LINK software is easy to install on popular SCADA systems and has been tested in several locations. RTX:LINK has been piloted in the Milford, Ohio, water system, where it has provided 24 hour access to current and historical tank levels, pump statuses and distribution system flows via mobile or desktop devices. RTX:LINK is also being tested in the city of Flint, Michigan, where it is being used to provide the same benefits as those in Milford along with a continuous, real-time understanding of water age. Using this technology has helped these water systems optimize operation, identify water losses or low pressure areas, and help predict available pressure for firefighting should any disruption occur in the distribution system.

Partners: Ohio Environmental Protection Agency (EPA), Association of State Drinking Water Administrators (ASDWA) and other state contributors

Challenge: Providing information, technical assistance and training to small drinking water systems (ongoing)

Resource: Webinars, workshops and workgroup to address challenges and treatment solutions for small systems



"It's very important that we provide small water systems with timely, easy to use, and accessible tools and training to assist in operating these critical public water systems, and the webinars and one-on-one meetings are perfectly suited to meet this need." – Ohio EPA Director Craig Butler

EPA ORD and Office of Water, in coordination with Ohio EPA and ASDWA, began hosting a monthly webinar series in 2015 targeted for state agencies on challenges and treatment solutions for small water systems. Because they have fewer resources than larger systems, small systems face enormous challenges in consistently providing safe and reliable drinking water. The series allows EPA to provide training and foster collaboration and dissemination of information, which, in turn, will help state agencies communicate the latest scientific advancements and current guidance to their small systems. It also serves as a forum for the invaluable flow of information, providing critical insight about the problems small water systems are currently encountering in their day-to-day interactions. With that increased awareness, ORD experts can then modify their research to solve real-world problems that small systems are experiencing.

As of July 2017, the series has attracted 24,374 participants from all 50 states, tribal nations, U.S. territories and international participants, and has provided 13,651 continuing education credit certificates (supported by Ohio EPA). Presenters include representatives from state drinking water agencies to help encourage communication between the states. For the webinar series schedule, registration and past recordings, visit EPA's website at (www.epa.gov/water-research/small-systems-monthly-webinar-series).

In addition to the webinar series, EPA hosts an annual small drinking water systems workshop in collaboration with ASDWA. This free, face-to-face workshop offers in-depth training and information for handling small drinking water systems problems and compliance challenges. It is primarily designed for state personnel responsible for drinking water regulations compliance and treatment technology permitting. The workshop typically attracts between 200-400 attendees from across the nation. This year's workshop will be held August 22-24 in Cincinnati; registration is available at (www.epa.gov/water-research). Formed during the 2011 workshop, ORD also leads a small drinking water systems technical communications workgroup to focus on targeted communication efforts between EPA and the states, taking into account the different needs system operators. In addition to EPA staff, the workgroup includes state regulatory agency and small water utility representatives from 13 states. A successful lead free communications tool has been developed, and the workgroup meets on a regular basis to decide on needed topics for the webinar series and to discuss the development of new tools.

Partners: Stafford County, VA; City of Baltimore, MD; York, PA

Challenge: Methods to address the effects of current and future changes in storm intensity, heavy precipitation events, and more frequent and severe floods in stormwater management planning (completed)

Resource: Technical support to identify barriers and provide tools, data, methods and actions to facilitate planning for impacts of more frequent and severe storms and floods in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and their partners



"Effective planning requires a clear understanding of the science. To that end, the help we are receiving from EPA scientists is critical to enabling us to come up with short and long range plans that will protect our lands and our waterways."
– Virginia Department of Environmental Quality Director David Paylor

Changes in storms and heavy precipitation events, along with land use changes such as development, can significantly affect the volume of stormwater runoff that municipalities must manage to protect public health and water quality. Local decision makers have identified the need for information that

would be useful for planning and adapting local stormwater management plans and controls to account for these changes.

To address this need, EPA ORD scientists and colleagues from NOAA held workshops and led other community-level efforts across states within the Chesapeake Bay and Great Lakes regions. The collaborations resulted in jointly derived insights into how scientific information on weather and climate can be most effectively disseminated to help communities increase the resiliency of stormwater systems in the face of current and future land use changes and more intense storms and floods. In particular, discussions focused on opportunities to implement infrastructure based on low-impact development practices, such as rain gardens that collect and absorb runoff from rooftops, sidewalks and streets, and other alternative management strategies. A summary report was prepared to inform states and communities on implementing stormwater management plans (<https://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=310045>).

Partners: Depts. of Environmental Protection (KY, MA, ME, NJ, PA and WV); Depts. of Environmental Management (AL and RI); CT Dept. of Energy & Environmental Protection; DE Dept. of Natural Resources and Environmental Control; Depts. of Natural Resources (GA, MD and Red Lake Nation (tribal)); MA Dept. of Fish & Game; NH Dept. of Environmental Services; Depts. of Environmental Conservation (NY and VT); Depts. of Environmental Quality (NC and VA); SC Dept. of Health & Environmental Control; TN Dept. of Environment & Conservation; VA Dept. of Game and Inland Fisheries; Susquehanna River Basin Commission; TN Valley Authority

Challenge: Develop a baseline monitoring network to detect long-term trends (ongoing)

Resource: Technical support to states and tribes through workshops and stream monitoring network development, in collaboration with the U.S. Forest Service and the U.S. Geological Survey



"As an interstate agency, the Susquehanna River Basin Commission (SRBC) certainly recognizes the value of the regional partnership EPA has assembled to address the need for collecting the data necessary for detecting changes to water quality and aquatic life communities over time, especially as it relates to any regional trends that may result from climate change effects. The establishment of an effective regional network is a bigger task than any single agency can undertake given the resources involved, and EPA's staff provided the needed leadership to establish and

guide the partnership, as well as the scientific expertise on the study methods for characterizing any future changing conditions." – SRBC Executive Director Andrew Dehoff

EPA ORD is working with our regional offices, states, tribes, river basin commissions and other entities to establish Regional Monitoring Networks (RMNs) for freshwater Wadeable streams. The objectives of the RMNs are to collect long-term biological, thermal, hydrologic, physical habitat and water chemistry data to document baseline conditions across sites and detect long-term changes. Consistent methods are being used to increase the comparability of data, minimize biases and variability, and ensure that the data meet data quality objectives. Continuous sensors are being employed when possible. RMN surveys build on existing state and tribal bioassessment efforts with annual sampling of a limited number of sites that can be pooled at a regional level. Pooling data enables more robust regional analyses and improves the ability to detect trends over shorter time periods. The collaborations across states, tribes and other entities resulted in the development of RMNs, some of which have collected data since 2012. Recently, EPA Regions 1, 2, 3 and 5, in coordination with their states and tribes, began developing RMNs for lakes and wetlands with the same objectives as the stream RMNs.

RMN data can be used for many purposes, over short and long-term timeframes. These applications include informing water quality and biological criteria development and protection planning priorities, refining lists of biological, thermal and hydrologic indicators, and detecting trends in commonly-used water quality and biological indicators. The RMN data also are important for detecting climate change effects in the context of biomonitoring. There are a number of climate change projections that are relevant to aquatic life condition, including increasing temperatures and changing frequency and magnitude of extreme precipitation events and frequency of summer low flow events. Managers will be able to use the monitoring data to help inform adaptive management.

Partner: New York City, Ohio EPA, Columbus, OH City Council

Challenge: Cleaning up after a wide area radiologic incident

Resources: Full scale demonstration of technologies in collaboration with the U.S. Department of Homeland Security (DHS)



"It's a great advantage to us to have the federal authorities look at these products, be able to test them, with input obviously from the local response organizations that are going to respond, to see what is the best product on the market." – Charlotte, NC Emergency Management Planner Michael Tobin

EPA ORD, in collaboration with DHS, conducted the Wide-Area Urban Radiological Contaminant, Mitigation and Cleanup Technology Demonstration in Columbus, OH in June 2015.

This demonstration provided first responders with options for response to a wide area radiological incident, such as a dirty bomb explosion or a nuclear accident, by showing the responders the operation feasibility of the tools in real time.

Five radiological decontamination technologies (including strippable coatings, gels and chemical foam) were demonstrated on an urban building. Decontamination technologies were applied to remove contaminants from the building's surfaces by physical and chemical methods. In addition, vehicle wash technologies as well as several approaches to contain wash water and radioactive particles were demonstrated. "Radiological contaminant mitigation" technologies are measures taken to reduce adverse impacts of radiological contamination on people and the environment, and to facilitate restoration of first responder services and critical infrastructure. Radiological contaminant mitigation technologies are designed for containing and removing radiological contamination on the surface in the first hours or days following a radiological event. Such technologies include "radiological particle containment," which is designed to prevent the spread of particles that might result from vehicle or foot traffic. Radiological particle containment technologies are applicable for early phase response to contain the radionuclides and to reduce radiation dose to responders and the public. Radiological contaminant mitigation also includes "gross decontamination," which is performed with the goal of reducing contamination levels. This reduction may not meet final cleanup levels but may be useful to mitigate some public hazard or to contain contamination.

While no live radiological agents were employed in this demonstration, critical operational insight was gained by the response community. This event continues the applied radiological cleanup research conducted by EPA ORD at bench and pilot scales over the last several years. In attendance were senior officials from Ohio EPA, Columbus, OH City Council, first responders from the U.S. and Canada, as well as representatives from New York City, the Navajo Nation, the United Kingdom, the Federal Emergency Management Agency, Battelle Memorial Institute and others. Watch the [Toolbox of Technology](#) video to learn more.